WATER CHESTNUT HARVEST PROGRAM 2015

A report on 2015 water chestnut mechanical and hand harvest activities in Lake Champlain and other waterbodies in Vermont

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Vermont Department of Environmental Conservation
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VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
LAKES & PONDS PROGRAM

Cover photos: top, hand harvested water chestnut; bottom, mechanical harvesting of water chestnut from Red Rock Bay, Lake Champlain (VTDEC photos)

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INTRODUCTION

The Vermont Department of Environmental Conservation (VTDEC) has actively managed water chestnut (*Trapa natans* L.) since 1982 and in partnership with The Nature Conservancy Vermont Chapter (TNC) since 1998. Many partners also contribute significant annual efforts to control water chestnut in other areas of the Lake Champlain Basin.

Dense mats of water chestnut flank either side of a boat channel in Lake Champlain, Dresden, NY (VTDEC)

Water chestnut is an annual aquatic plant that can form dense monocultures, choking out beneficial native plant species, reducing oxygen levels, negatively altering the recreation potential of the invaded water body, and reducing shoreline property values. First confirmed in Vermont in Lake Champlain in the 1940s, as of 2015, 77 Lake Champlain or associated tributary sites – 47 in Vermont and 33 in New York – are known to support water chestnut[1] as well as an additional 29 other waterbodies (see Appendix A). Additional water chestnut sites are known from sites associated with or adjacent to Lake Champlain in the Province of Quebec – the South and Richelieu Rivers, a few small ponds, Two Mountain Lake. All are under some level of management by Quebec partners.

This report describes the water chestnut harvest activities conducted by VTDEC (Part 1) and TNC (Part 2) in 2015. To support the goals of the Lake Champlain Basin Program's (LCBP) Ecological Indicators task force, water chestnut indicators were developed for management efforts (representing VTDEC, TNC and other partners) and are presented in Appendix B.

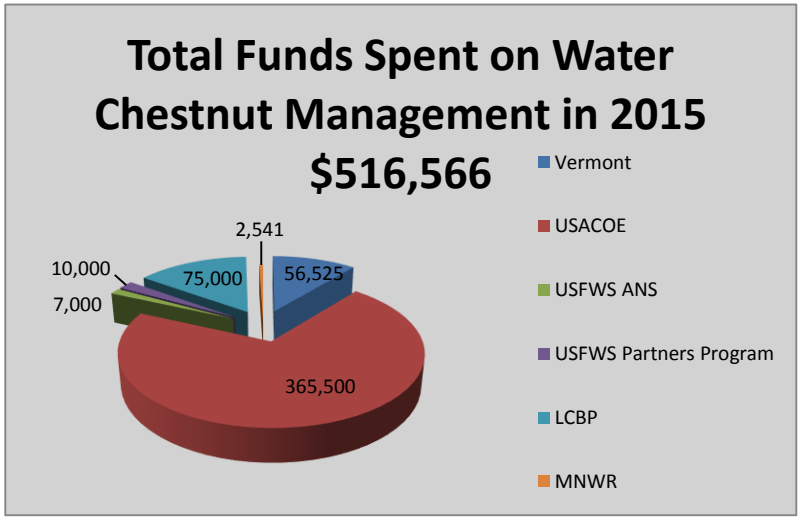
PART 1: VTDEC PROGRAM

VTDEC management goals for water chestnut are to significantly reduce the negative impacts of this invasive plant in Lake Champlain and other waters in Vermont, and to prevent its further spread. VTDEC's program involves hand and mechanical harvesting with the majority of the work conducted under contract. Hand harvesting is used to control sparse populations of water chestnut or populations inaccessible to mechanical harvesting equipment. Mechanical harvesting is used to control dense and easily accessible mats.

[1] An estimated 9.7 miles of South Lake Champlain, from Dresden south to Whitehall, New York, also support numerous water chestnut sites but these sites have not been delineated and are not included in the 77 known to support water chestnut sites.

Funds supporting the program in 2015 were represented by state and federal sources and are shown in Figure 1.

Figure 1. 2015 water chestnut management funds



Funds supporting the mechanical harvesting element in 2015 totaled $311,020. VTDEC awarded two contracts and three memorandum of understandings (MOU) to support this element. Total cost of 2015 mechanical harvest contracts and one of the three MOUs was $295,025. Table 1 summarizes the sources and allocation of funds supporting the 2015 mechanical harvesting element.

Table 1. Allocation of funds for VTDEC 2015 water chestnut mechanical harvesting element

Mechanical Harvesting Element	LCBP	USACE	USFWS Partners	USFWS ANS14	VTDEC	Total
Personnel, Fringe, Indirect: Environmental Scientists (2)					$12,995	**$12,995**
Mechanical Harvest Contract: Aquatic Control Technology Inc.		$290,000				**$290,000**
Compost Contract: Champlain Valley Compost Company					$6,525	**$6,525**
MOU: Red Rock Road access				$1,500		**$1,500**
TOTAL	**$0**	**$290,000**	**$0**	**$1,500**	**$19,520**	**$311,020**

Funds supporting the hand harvesting element in 2015 totaled $221,995. VTDEC awarded two contracts and two grants to support this element. Total cost of 2015 hand harvest contracts and grants was $180,100. Table 2 summarizes the sources and allocation of funds supporting the 2015 hand harvesting element.

Table 2. Allocation of funds for VTDEC 2015 water chestnut hand harvesting element

Hand Harvesting Element	LCBP	USACE	USFWS Partners	USFWS ANS	VTDEC	Total
Personnel, Fringe, Indirect: Environmental Scientists (2) UVM Rubenstein Intern			 $3,060		$37,995	**$37,995** **$3,060**
Hand Harvest Contract: Lakeside Restoration Services	$75,000	$73,500	$6,100	$1,500		**$156,100**
Supplies			$840			**$840**
Other: grant to DFPR, invasive coordinator for volunteers grant to Friends of Missisquoi Bay, HP	 $20,000*			 $4,000		 **$20,000** **$4,000**
TOTAL	**$95,000**	**$73,500**	**$10,000**	**$5,500**	**$37,995**	**$221,995**

* Funds awarded in 2014

Water chestnut mechanical harvesting activities in Vermont are authorized under Aquatic Nuisance Control Permit 2014-H05 issued to Aquatic Control Technology on November 14, 2014. Mechanical harvesting activities in Lake Champlain are authorized in Lake Champlain south of the Chimney Point Bridge for ten years. Hand harvesting activities do not require a control permit in Vermont (10 VSA §1455); however, access for hand harvest activities at Vermont Department of Fish and Wildlife public access areas requires a Special Use Permit. A permit was applied for and authorized prior to the start of hand harvesting. In New York, water chestnut hand harvest activities in Lake Champlain and associated waters are authorized under Adirondack Park Agency Permit 2001-47A issued April 26, 2011 to the New York State Department of Environmental Conservation and VTDEC jointly. This permit authorizes hand and mechanical harvesting of water chestnut from Lake Champlain in the towns of Dresden, Putnam, Ticonderoga, Crown Point, and Moriah, New York and expires in April 2020.

Methods

As an annual species, repeated harvesting of water chestnut rosettes (plants) before mature seeds drop can significantly reduce populations and be an effective means of control. Due to water chestnut's rapid growth habits and long-term seed viability, constant "maintenance" management is required in any water body where a population has historically occurred.

Contracted mechanical harvesting equipment used in 2015 included: two mechanical harvesters each with 800 cubic feet storage capacity; a high-speed transport barge; a shore conveyor; and three, four-wheel drive, one-ton dump trucks. To improve efficiency, mechanical harvesters off load to a high-speed transport barge and the barge carries harvested material to the off-load access point. Harvested material is transported by one-ton dump truck to a de-water or compost site. The de-water site is temporary; all harvested water chestnut material is eventually moved to a compost site. At the compost sites, water chestnut is piled into windrows for turning.

Motorized boats are used to access Lake Champlain sites and pontoon boats used to transport contracted hand harvest crews to water chestnut sites not adjacent to access points. Kayaks and canoes are used to access other water body sites and some Lake Champlain sites. Go-Devil shallow water boats are used to access sites within the Missisquoi National Wildlife Refuge and are critical to accessing shallow and heavily vegetated sites.

At each hand harvest managed site, systematic searches are conducted to look for and remove all water chestnut rosettes (multiple rosettes may grow from a single plant stem) found. Pulled water chestnut rosettes are collected in plastic baskets or sleds strapped to the front of kayaks, Gardeners Supply leaf tip bags or other containers. The number and weight of rosettes pulled are estimated by counting and weighing a subset. All pulled rosettes are disposed of at upland, non-wetland sites. When possible, sites are targeted two or more times annually.

A VTDEC staff person provides contract oversight, obtains landowner permission for access and disposal of water chestnut, and conduct surveys, searches, and some water chestnut hand harvesting. Other VTDEC Lakes and Ponds Management Section staff assist with removal efforts, surveys and searches, and conduct outreach efforts.

Harvesting water chestnut by kayak (VTDEC)

Results

In 2015, 77 Lake Champlain or associated tributary water chestnut sites were identified for management, mechanical, hand harvesting or both methods, and 76 were targeted. These sites are located between Rock River Bay, Highgate, Vermont and Ottenburgh Ramp, Dresden, New York on both sides of the lake. Nine sites were identified for mechanical harvesting, 1 site for mechanical and hand harvesting, and 66 were identified for hand harvesting. All 11 mechanical harvesting sites and 66 of the 67 hand harvest sites were targeted in 2015. The one site not visited was Converse Bay in Charlotte, Vermont.

2015 Lake Champlain water chestnut harvesting efforts mirrored 2014; the southernmost control site, Ottenburgh Ramp, is approximately 1.5 miles below the Narrows of Dresden.

All 10 mechanical harvesting sites were managed by a contractor. The northernmost mechanical harvesting site remained Peters Bay, Benson, Vermont. Removed water chestnut was offloaded at a private access in red Rock Bay and transported by dump truck by the harvesting contractor to one of two sites: a temporary dewatering site and a compost site. Material at the dewatering site was later transported to a second compost site.

Of the 66 Lake Champlain hand harvest sites targeted in 2015: 57 sites were managed by contracted crews; 2 sites by contracted crews and TNC; 3 sites by the Friends of Missisquoi Bay; 1 site by the Friends and VTDEC; 1 site by VTDEC; 1 site by VTDEC and partner, The Lewis Creek Association; and 1 by TNC. No water chestnut was found at 22 of these 66 sites. No new Lake Champlain hand harvest sites were added.

Contracted hand harvest crew with a pile of 44,642 water chestnut rosettes in the foreground, all removed from Blissville wetland pond (VTDEC photo)

In addition to Lake Champlain, 23 other water body sites with water chestnut were slated for hand harvesting. All 23 were targeted: 9 sites by contracted crews; 7 sites by VTDEC; 4 sites by the Friends of Missisquoi Bay/Missisquoi National Wildlife Refuge staff; and 3 sites by TNC.[2] Four additional water chestnut waterbodies are designated as "inactive" and were not visited in 2015.
Two new other water body sites were discovered in 2015: an unused slate quarry pond in Blissville and Coggman Creek in West Haven. The Blissville pond was confirmed by VTDEC and managed by contracted crews, VTDEC and TNC hand harvesting. An estimated 221,874 water chestnut rosettes weighing over 29,623 pounds were removed during 8 work days. The Coggman Creek site was confirmed and managed by TNC and is described in Part II on page 36. With these finds, the total number of other waterbody water chestnut sites rose to 29.

A 2015 mechanical and hand harvest operations summary for VTDEC and VTDEC's contractor and grantees follows. Summary statistics for Lake Champlain efforts are provided in Appendix C and for the 29 other waterbodies, Appendix D.

Mechanical Harvesting Contract – Aquatic Control Technology

- $290,000 were awarded to Aquatic Control Technology (ACT) of Sutton, Massachusetts under one contract. The contract was awarded in 2014.
- ACT mechanical harvesting commenced on July 13th and ended on August 24, spanning 31 total work days.
- Two crews worked one of two six-hour shifts, 7AM to 1PM or 1-7PM throughout the 6-six-week season.
- Each harvesting crew is represented by an on-site supervisor, harvester operators, high-speed transport vessel operator and dump truck drivers.
- ACT targeted 10 Lake Champlain sites representing approximately 170 acres. Due to high water levels, the near shore areas of three northern sites (Peters Bay, Red Rock Bay, and NY Light 14 and south) were targeted at the beginning of the season but fully completed at the end of the season when lower water levels prevented near shore access.
- Over 746 hours were spent mechanically harvesting water chestnut, 56% on the New York side of the lake and 44% on the Vermont side.
- 530 mechanical harvester loads of harvested water chestnut representing 7,420 cubic yards of material or 1,007 tons wet weight were removed.

[2] TNC management details are included in Part II. In addition to Lake Champlain and other water body sites, TNC also managed other sites in South Lake Champlain and South Bay.

- Dump trucks made 530 trips to one of two sites 2.5 miles from the off-load site, both sites were new in 2015: a temporary dewatering site and a compost site. The average cost of one mechanical harvested water chestnut load was approximately $547 per load.

Mechanical Harvesting Access MOU – Red Rock Bay private property

- $1,500 was provided to a private landowner on Red Rock Bay under a memorandum of Understanding for mechanical harvester offloading and site access. This site represents the base of operations for the mechanical harvesting crews and the only offloading site used by the mechanical harvesters in 2015.
- Only minor repairs to a road installed in 2008 under a VTDEC contract were required.

Mechanical harvesting base of operations, Red Rock Bay (VTDEC photo)

Temporary Dewatering MOU – private property

- A Memorandum of Understanding was established with a private landowner for the temporary dewatering and drying of mechanically harvested water chestnut.
- 530 loads were placed at the site, pushed into piles by an excavator and allowed to dry for one to two weeks. All material was removed by the end of August 2015.

Compost MOU – private property

- A Memorandum of Understanding was established with a private landowner for dewatering and composting of mechanically harvested water chestnut.
- 10 loads were placed at the site and once the material is composted, the material is for the landowners' use.

Compost Contract – Champlain Valley Compost Company

The tractor-pulled compost turner turns a windrow of water chestnut with added bulking agent (VTDEC photo)

- $6,525 were awarded to Champlain Valley Compost Company (CVCC) in 2014.
- The material from the dewatering site (520 loads) was transported 5.2 miles to a compost site by the compost site owner. The water chestnut material was placed parallel to the slope into two windrows.
- On October 1st approximately 60 yards of semi-dry, cow manure from the methane digester at Blue Spruce Farm in Bridport, Vermont were added to the two windrows with a skid steer loader owned and operated by the site owner. The windrows were also trimmed to a width of 9 feet to accommodate the compost turner.
- Using a tractor-pulled compost turner, CVCC turned the windrows on October 9th to fully incorporate the cow manure and reduce the bulk density to facilitate passive aeration within the windrows.
- On October 23rd, CVCC turned the windrows for a second time to maintain the compost process. Based on observations of an elevated temperature, pleasant odor, and further darkening color, the compost process was proceeding normally. No mix corrections were necessary.
- The volume of finished compost produced from the 520 dewatered water chestnut loads is estimated to be between 275-330 cubic yards. The material is the property of the compost site owner.

VTDEC Hand Harvesting

- One staff person provided oversight of the two contracts and two grants, connected weekly with most contract/grant leads, reviewed and approved invoices, and tracked and summarized collected data.
- Staff targeted 8 other water body sites and with TNC and the contractor, 1 additional site, for water chestnut control, contributing an unassessed number of hours searching for and removing over 26,192 rosettes.
- Staff conducted 31 water chestnut surveys between June 30th and September 15th: 18 on Lake Champlain and associated tributaries, and 13 on other water body sites.
- All Vermont Department of Fish and Wildlife public boat accesses in the Lake Champlain Basin were visited in 2015 to maintain aquatic invasive species warning signs with information about water chestnut and current Vermont transport laws. Aquatic invasive species transport law rack cards were stocked at many of these accesses and any damaged brochure boxes replaced.
- Two, day-long Vermont Invasive Patrollers (VIP) workshops were attended by 21 people. Water chestnut is one of a number of species participants become trained on. Over 80 hours collectively were contributed by 20 VIP volunteers in their surveying efforts of 15 Vermont lakes in 2015. One new invasive species infestation – a species not previously known from the state - was reported as a result of these efforts, the macro algae starry stonewort in Lake Memphremagog.

- Staff held three public water body access training workshops. In addition to greeter etiquette, these workshops provide specific information on water chestnut and other aquatic invasive species, and current Vermont transport laws.

Hand Harvesting Contract - Lakeside Restoration Services

- $156,100 were awarded to Lakeside Restoration Services (Lakeside) of Fair Haven, Vermont for hand harvest services under two contracts: an amendment to a three-year contract awarded in 2014 and a second contract awarded to add additional funds to target one of two new other water body sites confirmed in 2015, Blissville quarry pond.
- Lakeside hand harvesting commenced on June 22nd and ended on August 23, spanning 39 total work days.
- A crew of 2-18 worked an average of 40 hours per week throughout the 9 week season.
- Lakeside targeted 59 Lake Champlain and associated tributaries sites, and 9 other waterbody sites. Over 3,630 hours were spent removing approximately 19 tons of water chestnut from all 68 sites.
- In Lake Champlain, the 59 sites targeted span an estimated 136 miles of Lake Champlain shoreline between Ferrisburg and Benson, Vermont - approximately 88 miles in Vermont and 48 miles in New York. The southernmost site targeted was Peters Bay, Benson, Vermont.

Hand Harvesting Grant - Friends of Missisquoi Bay

- $4,000 were awarded to the Friends of the Missisquoi Bay to support a partnership with Missisquoi National Wildlife Refuge staff on water chestnut search and hand harvest efforts primarily within the Refuge.
- The Friends contributed an additional $500 and the Refuge contributed $2,041 in in-kind services towards the 2015 effort.
- A crew of two commenced work on July 20th and ended on July 31st for a total of 12 work days.
- Priority survey areas were determined by previous control operations – annually since 2007 - as well as biological sensitivity of Refuge wetlands during black tern breeding season. Operations were coordinated by a Refuge biologist to manage any potential conflict with other Refuge work, but also to maximize water chestnut removal in key problem areas.
- A total of 210 person hours were spent surveying for and harvesting 1,045 water chestnut rosettes, an estimated 135 pounds from two Lake Champlain sites (Dead Creek Delta and Shad Island) and two other water body sites within the MNWR (Big Marsh Slough and Cranberry Pool).
- No water chestnut was found at two previously known sites, Long Marsh Bay and channel, and Cabot-Clark Marsh.
- Total area surveyed included a minimum of 716 acres and is shown in Figure 2.

Figure 2. Total areas surveyed in MNWR in 2015 (source: USFWS, MNWR)

Hand Harvesting Grant – VFPR Invasive Species Volunteer Coordinator

- A $20,000 grant was awarded to the Department of Forest, Parks and Recreation to support water chestnut volunteer coordination efforts of an invasive species coordinator over three years, 2015 through-2017.
- The coordinator assisted VTDEC staff transition water chestnut volunteer oversight from TNC in 2015. The coordinator worked with TNC on volunteer workday planning; participated in multiple TNC work days with volunteers; became familiar with sites appropriate for volunteer workdays; reviewed collected data; prioritized water chestnut sites for future volunteer workdays; and met with TNC staff to transition volunteer information.

In 2015, water chestnut removed from most mechanical harvesting sites was increased over 2014 except for one site, Maple Bend. The number of loads at the southernmost Lake Champlain control site, Ottenburgh

Ramp, was also increased over 2014 however this site has yet to be fully targeted. Harvest trends for all ten 2015 mechanical harvesting sites are shown in Figure 3.

Figure 3. Harvest trends for all ten 2015 mechanical harvesting sites.

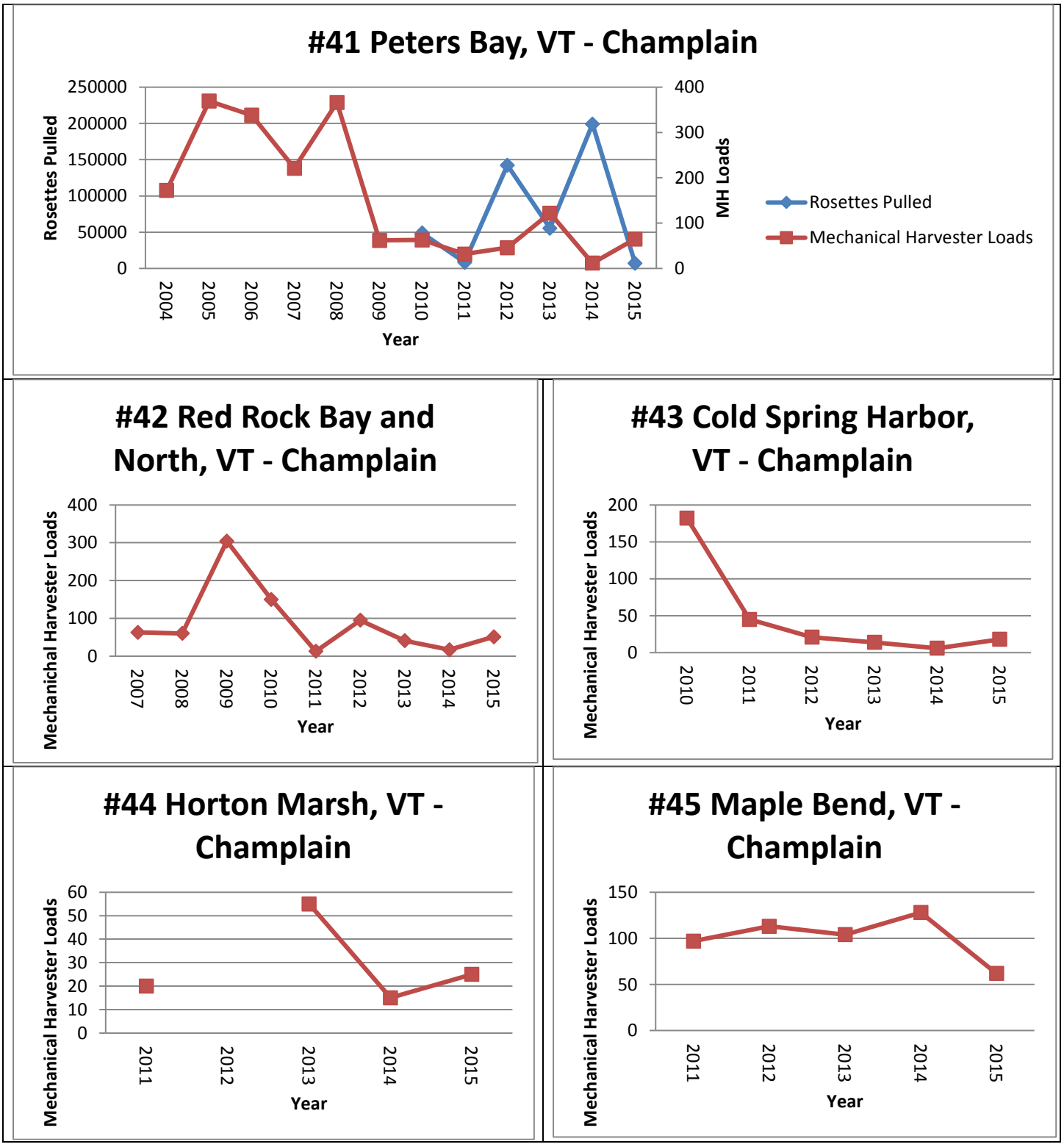
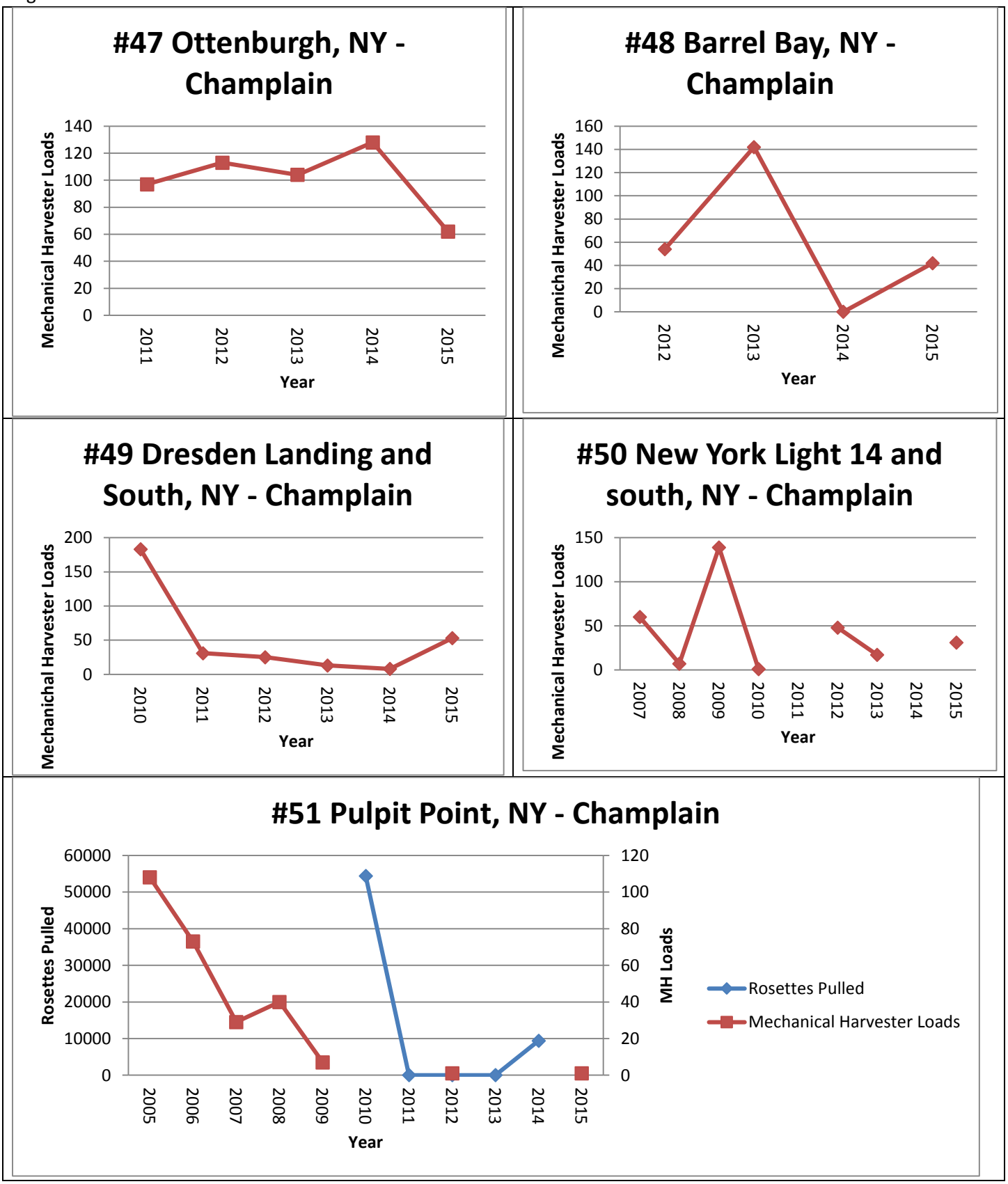


Figure 4 continued



Of the 67 Lake Champlain hand harvest sites, an increase in water chestnut was documented at 23, a decrease at 18, 25 sites had no water chestnut and one site was not visited. The most significant decrease was at was at the South of Gourlie Point site where only 49 rosettes were found and removed in 2015 compared to 4,728 in 2014 (see Figure 4). The most significant increase was at the Bed Back by Railroad site, Putnam, NY; rosette numbers pulled increased from 30,301 removed in 2014 to 479,354 removed in 2915 (see Figure 5).

Figure 5. Number of water chestnut rosettes removed from the South of Gourlie Point Site, 1999-2015

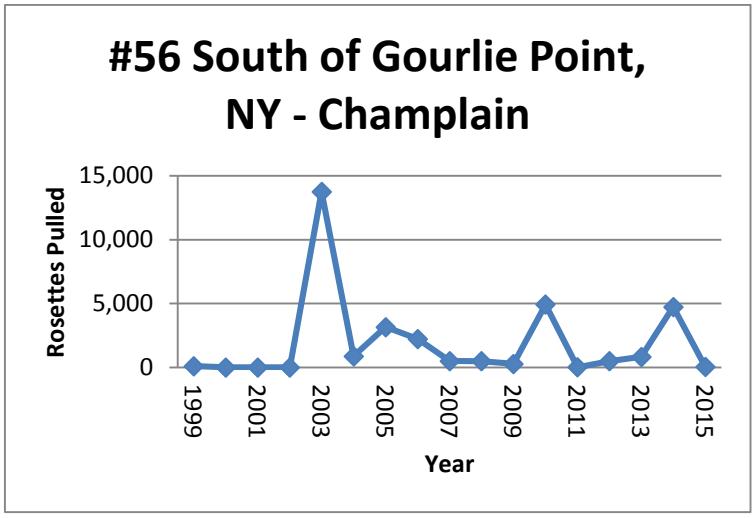
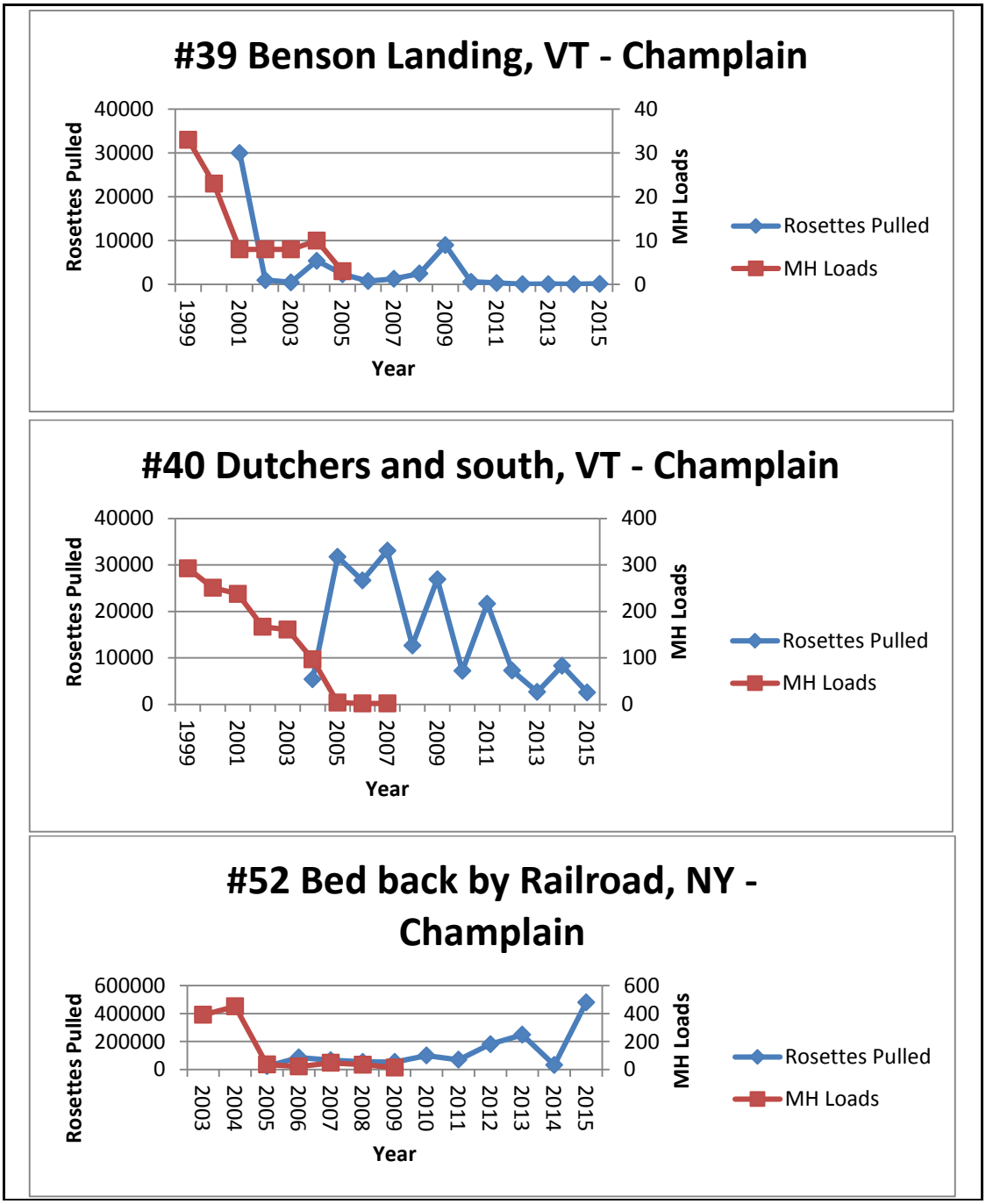


Figure 5 provides trends for six long-term control sites in Lake Champlain that have shifted from mechanical harvesting to hand harvesting. These sites originally supported dense water chestnut mats. Mechanical harvesting was used to reduce populations to levels where now management by hand harvesting only is required.

Figure 6. Six long-term control sites in Lake Champlain that trended from mechanical to hand harvesting



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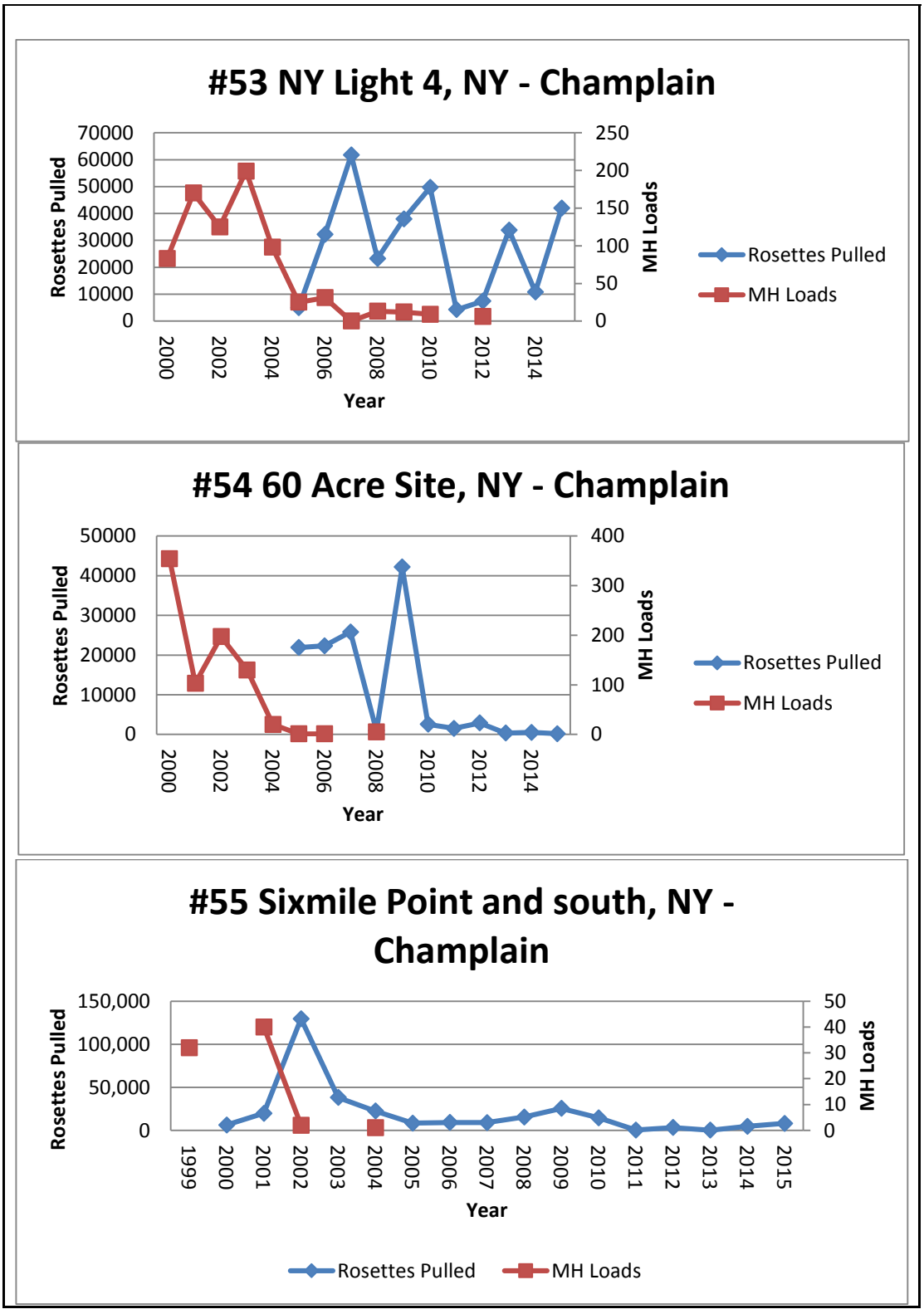
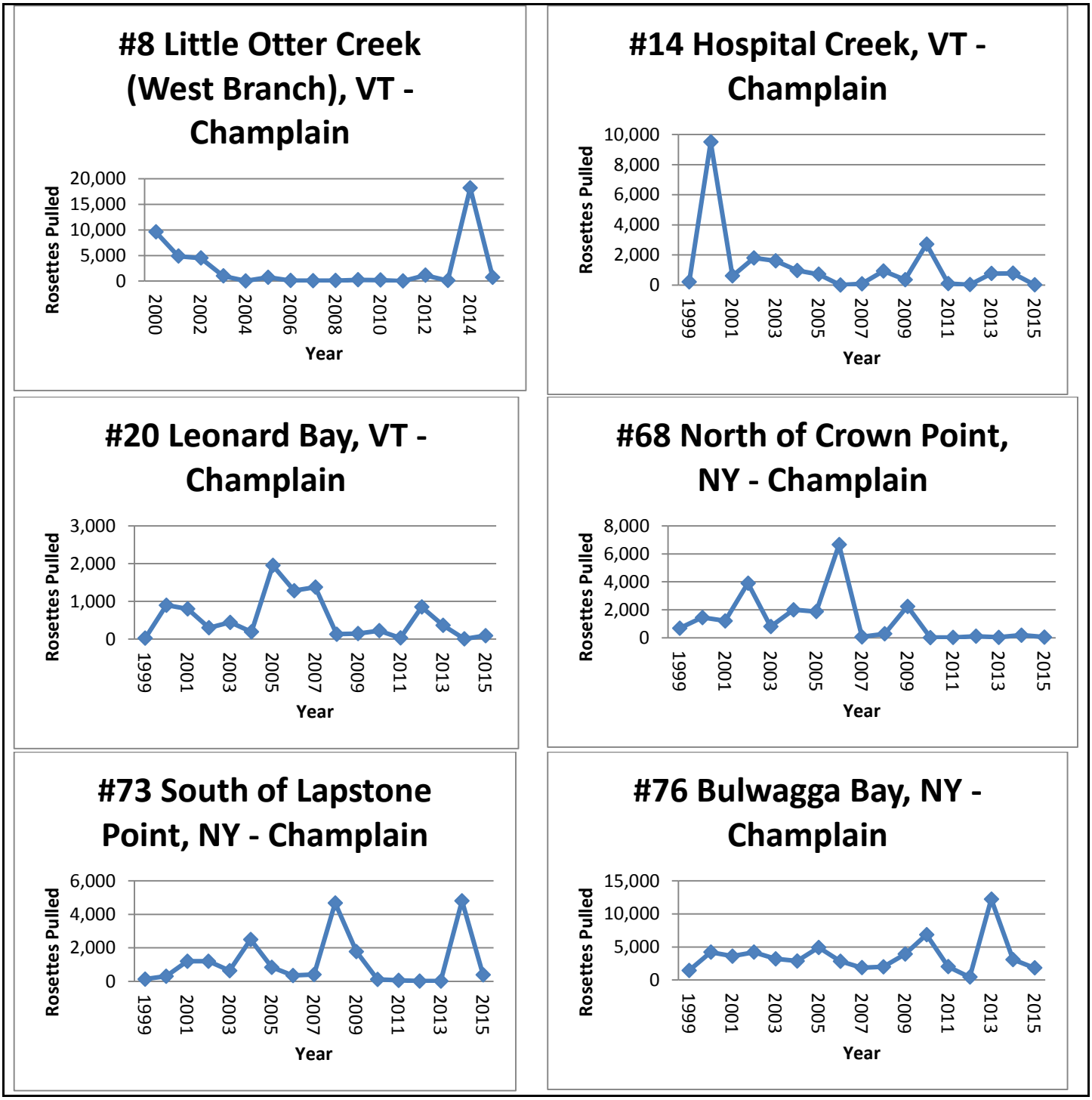


Noteworthy site-specific results for six Lake Champlain long-term hand harvest sites are shown in Figure 6.

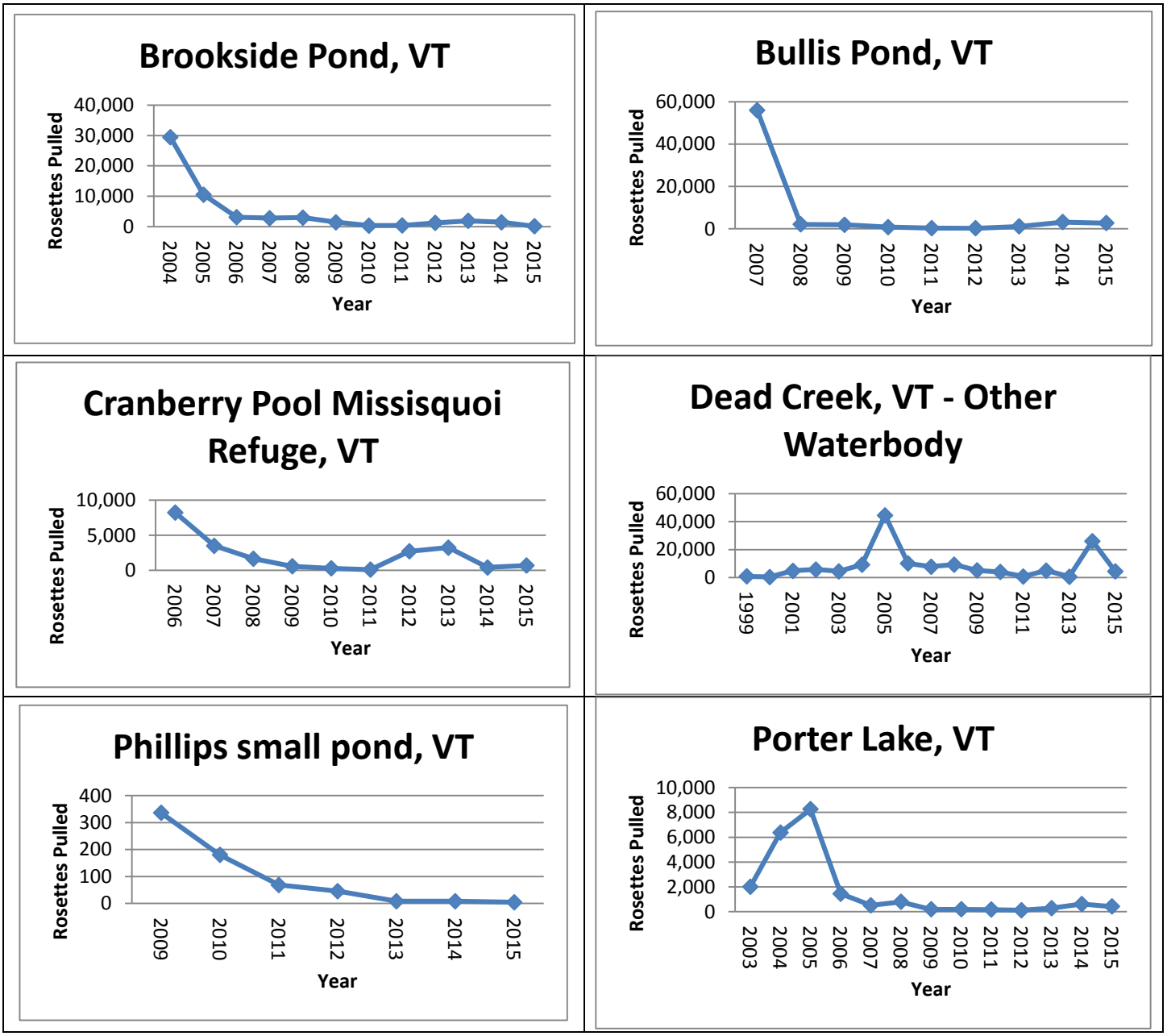
Figure 7. Control trends for six Lake Champlain long-term hand harvest sites



The estimated total weight of water chestnut harvested in 2015 from the 25 of 29 active other water body sites in Vermont by VTDEC, VTDEC's contractors and grantees, and partners (except TNC) was in excess of 15.15 tons wet weight. These groups collectively worked over 964 hours searching for and harvesting water chestnut. Appendix D summarizes these other waterbody search and harvest efforts.

Water chestnut harvest at the other water body sites generally continues to exhibit decline or stabilization. Of the 25 active sites, 2 sites were new in 2015; 7 had no water chestnut; 9 exhibited a decline in the amount harvested; and 7 sites had an increase in the amount harvested. Figure 7 provides trends in harvest data for six long-term other water body sites.

Figure 8. Control trends for six other water body hand harvest sites in Vermont



Conclusions

The goal of the current program remains to shift from expensive mechanical harvesting to maintenance hand harvesting, with ongoing surveillance in all areas, and prevent further spread of water chestnut. Both Lake

Champlain and other water body water chestnut sites managed annually generally continue to exhibit a pattern of decreasing water chestnut abundance or stabilization. There are exceptions; despite ongoing harvest activity, water chestnut increases in abundances are noted at some sites, in some management years. Environmental conditions, fluctuations in water levels influencing both spread and accessibility, and a lack of understanding of water chestnut pathways are likely contributing factors.

A 9.7 mile section of Lake Champlain between Dresden and Whitehall, New York, has sites with water chestnut populations and no consistent management effort. These sites have not been delineated. In this section of Lake Champlain, there is at least one large water chestnut mat site in West Haven, Vermont estimated at 60 acres and known as the Drowned Lands; numerous dense mats in South Bay under partial management by the Town of Dresden; and a number of areas along both sides of the lake where hand harvesting is required.

Although water chestnut has been found in 29 other Vermont waterbodies in Vermont, early detection and rapid response efforts has led to effective control using hand harvesting only, and in some waters, water chestnut elimination.

While VTDEC and partner all harvest efforts span 34 years at an estimated expenditure of over $11.9 million, significant milestones have been made in the reduction of water chestnut in Lake Champlain and other waterbodies in Vermont. These notable successes support the need for continued management. The configuration, extent and distribution of Lake Champlain and Vermont inland water body sites, and the biology of water chestnut will necessitate some level of water chestnut harvest and on-going surveillance *well into the future* if this species is to be successfully managed. The reality of on-going, annual water chestnut management must be realized and fiscally supported to prevent this non-native invasive species from re-bounding at managed sites or spreading to other areas.

Acknowledgements

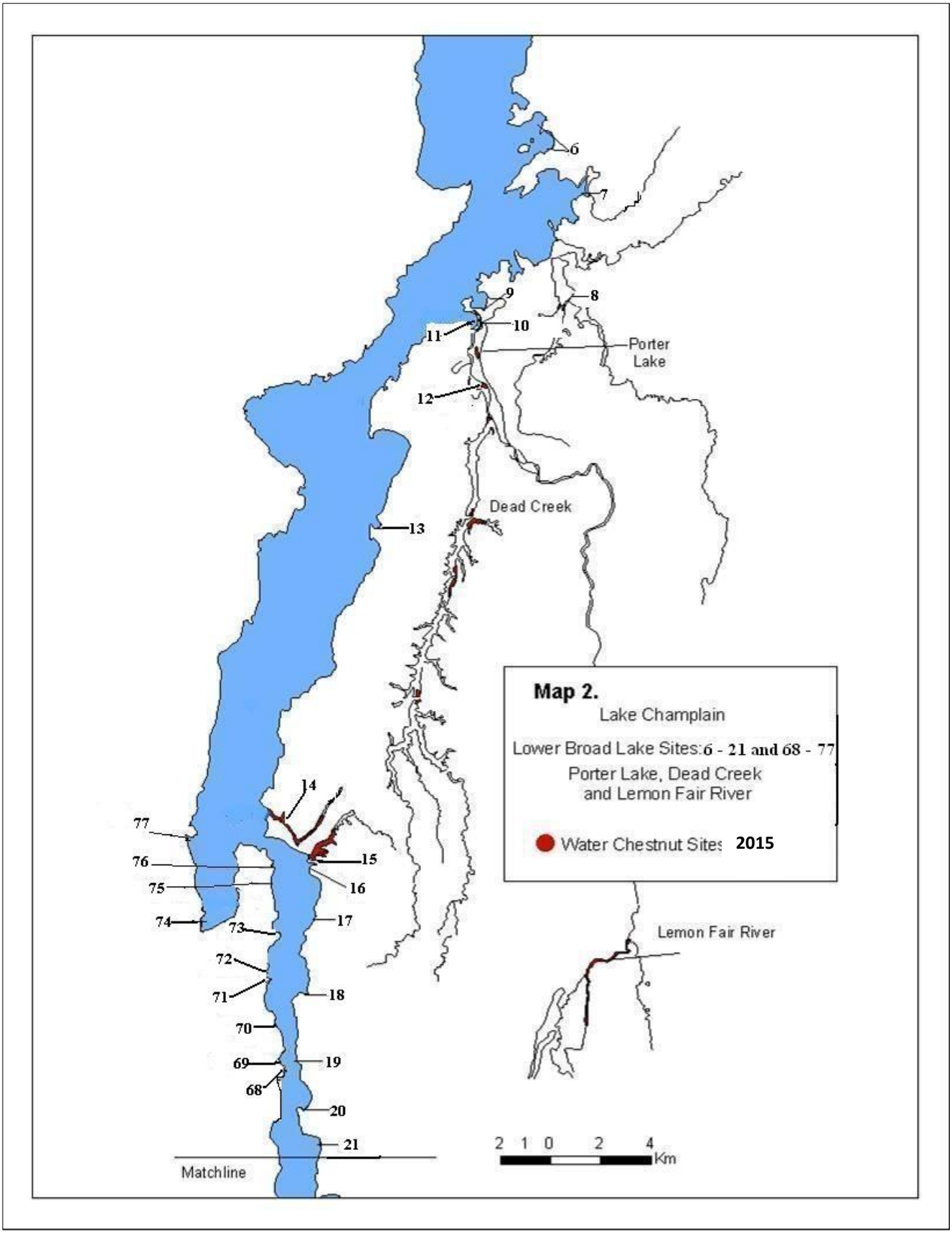
Funds supporting the hand harvesting element of the 2015 Water Chestnut Management Program were provided by the Lake Champlain Basin Program, a funder and supporter of this effort since 1991; USFWS through the Lake Champlain Basin ANS Plan; USFWS Partnership Program, another long-time supporter; Army Corps of Engineers Aquatic Plant Control Program; and VTDEC.

The success of water chestnut management in Lake Champlain and inland Vermont waterbodies is a direct result of on-going partner efforts. VTDEC recognizes the commitment and efforts of the Friends of Missisquoi Bay, Missisquoi National Wildlife Refuge, TNC, Vermont Department of Forests, Parks and Recreation, Lewis Creek Association and Lake Carmi Campers Association.

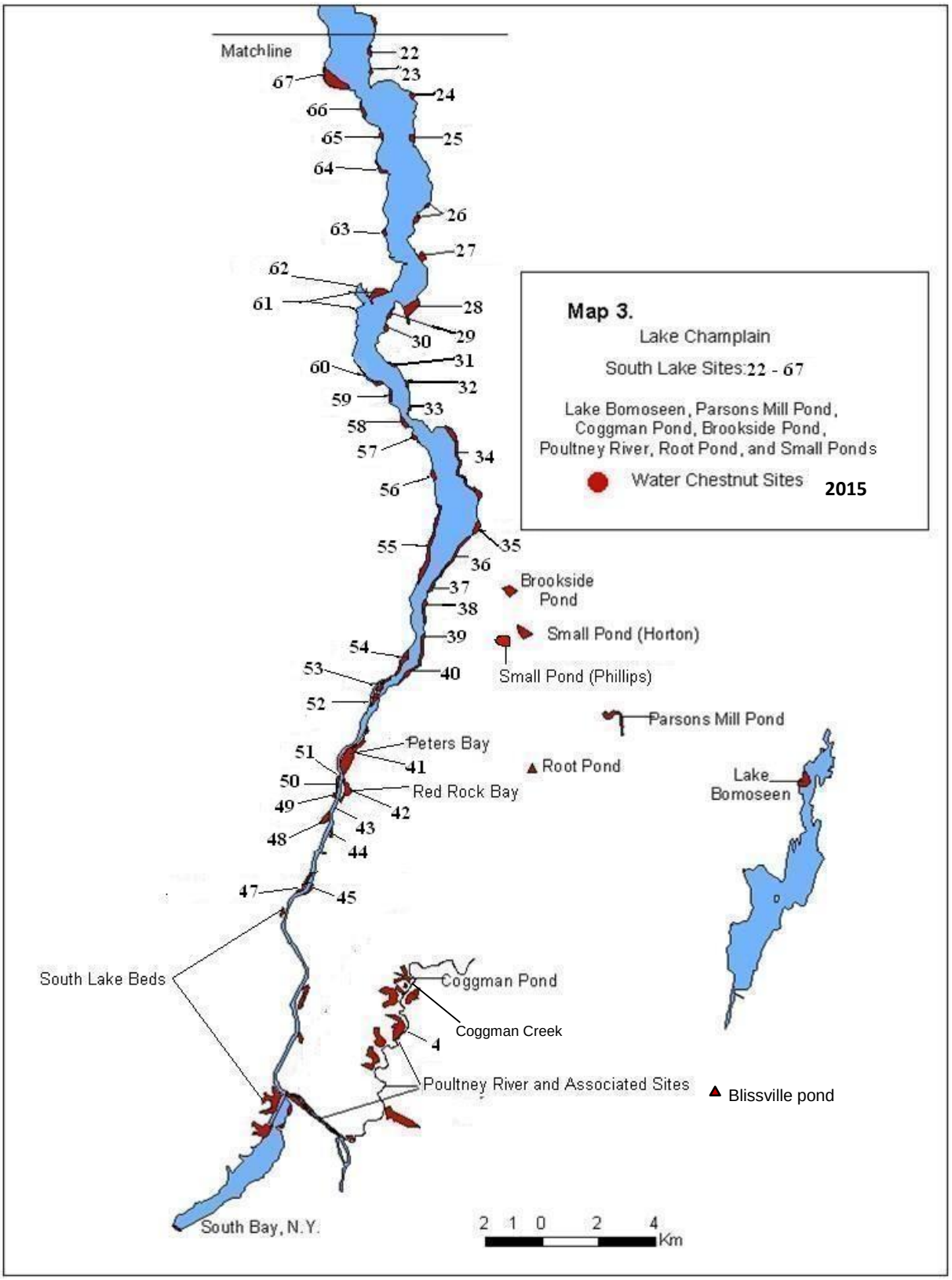
Appendix A. Water Chestnut Site Maps

Map 1. Northern Lake Champlain sites: Missisquoi Bay

Map 2. Lake Champlain: lower broad lake, Porter Lake, Dead Creek sites and the Lemon Fair River



Map 3. Lake Champlain: south lake sites, Lake Bomoseen, Parsons Mill Pond, Coggman Pond, Brookside Pond, Poultney River, Root Pond, and small ponds



Appendix B. Water chestnut indicators for 2015 management efforts

Indicator	PSR*	Suggested Measures	Values	Currently Collected?	Who Should Collect?	Numerical values	Spatial Resolution	Collection Frequency (minimum)	Reported Frequency (minimum)
Area infested with water chestnut	P	Total number of infested acres[1]	^	Y	VTDEC	3,229 acres		Annual	Annual
					NYSDEC				
					TNC				
					MNWR				
					QUEBEC	808 acres			
		Number of acres <25% surface coverage	^	Y	VTDEC	1955 acres		Annual	Annual
					NYSDEC	(included in VTDEC #)			
					TNC	800 acres			
					MNWR	(included in VTDEC #)			
					QUEBEC	808 acres			
		Location of mechanical harvesting: miles north of Whitehall, NY	**9.7**	Y	VTDEC	10	South Lake	Annual	Annual
		Number of lake segments infested	**6**	Y	VTDEC	6	Lake Segment	Annual	Annual
Management resources	R	Total Dollars spent on management[2]	**$**	Y	VTDEC	$514,025		Annual	Annual
					NYSDEC	$65,659			
					TNC	$0			
					MNWR	$2,541			
					QUEBEC	$40,000 est.			
Mechanical management	R	Tons of water chestnut removed through mechanical harvesting	^	Y	VTDEC	1,007 tons		Annual	Annual
					NYSDEC	1,193 tons			
Handpulling management	R	Tons of water chestnut removed through handpulling	^	Y	VTDEC	19.03 tons		Annual	Annual
					TNC	2.75 tons			
					MNWR	0.09 tons			
					QUEBEC	1 ton approx			
		Number of handpulling hours in Lake Champlain and tributaries	^	Y	VT contracted	3,630.4 hrs		Annual	Annual
					TNC	400 hrs			
					MNWR	210 hrs			
					QUEBEC	300 hrs est.			
					VTDEC	69.25 hrs			
					Others	70.25 hrs			

* Pressure, State, Response Column: framework for monitoring water chestnut indicators

1 Total acreage increased as known sites were added to the acreage map. Quebec acreages in the Basin added 2013.

2 As of 2014, figure includes Quebec and NYSDEC funding and 2015, MNWR.

Appendix C. Water Chestnut Harvesting Summary Statistics for Lake Champlain Sites (77)

Missisquoi Bay Segment VT – 5 sites

Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
1. Mouth of East Branch Missisquoi River (MNWR) 45”00’33 N / 73”07’54 W	Highgate Springs	HP-MNWR		Part of other hours worked		
2. Dead Creek Delta 44”58’30N / 73"07’46	Highgate Springs	HP-MNWR		4	3	24
2. Dead Creek Delta 44”58’30N / 73"07’46	Highgate Springs	HP-DEC	07/15/15	5	0	0
3. Outside Entrance to Big Marsh Slough (MNWR) 44”58’32 N / 73”08”03 W	Highgate Springs	HP-MNWR		Part of other hours worked	0	0
4. Shad Island (MNWR) 45”00’33 N / 73”08’45 W	Highgate Springs	HP- MNWR		26	1	16
5. Rock River Bay 44”59’32N / 73”05’29W	Highgate Springs	HP-DEC	07/15/15	5	0	0

Main Lake Segment VT – 1 sites*

Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
6.Converse Bay DFW Access & Bay South 44"17'19N / 73"16'01W	Charlotte	HP-DEC				

* McNeil Cove, Charlotte managed; no water chestnut since 1999.

Otter Creek Segment VT – 6 sites

Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
7. Town Farm Bay/Kimball Brook 44"16'60N / 73"16'01W	Charlotte	HP-DEC	09/13/15	4	0	0
7. Town Farm Bay/Kimball Brook 44"16'60N / 73"16'01W	Charlotte	HP-LCA	07/7/15			2
8. Little Otter Creek (West Branch) 44"13'28N / 73"01'38W	Ferrisburgh	HP HP HP	06/25/15 07/08/15 08/03/15	90 2 17.5	25 0 0.2	639 0 3

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Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
9. Porter Bay 44"13'37N / 73"18'58N	Ferrisburgh	HP-DEC	09/15/15	1	0	0
10. Otter Creek North 44"13'31N / 73"19'27W	Ferrisburgh	HP	08/03/15	2.5	0	0
11. Fields Bay 44"13'15N / 73"19'09W	Ferrisburgh	HP	08/03/15	15	250	1,820
12. Otter Creek South 44"12'23N / 73"19'16W	Ferrisburgh	HP	08/03/15	5	0	0

Port Henry Segment VT – 1 site

Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
13, Basin Harbor 44"11'46N / 73"21'52W	Panton	HP	07/08/15	1	0	0

South Lake Segment VT – 32 sites

Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
14. Hospital Creek a. 44”02’32N/73”25’06W (**L**)	Addison	HP	07/07/15 08/07/15	4.5 3	0.6 0	15 0
14. Hospital Creek b. 44”02’20N/73”24’40W	Addison	HP	07/07/15	4.5	0	0
15. Whitney Creek a. 44"01'40N / 73"24'05W (**L**)	Addison	HP	07/07/15	4.5	0.7	18
15. Whitney Creek b. 44”02’50N / 73”24’40W	Addison	HP	06/24/15 08/07/15	42.5 3	12.4 1.8	179 17
16. McCuen Slang 44"01'28N / 73"23'67W	Addison	HP	07/07/15 08/05/15	36 8	2.1 0.2	107 4
17. Bridport Town Beach 43"59'55N / 73"24'04W	Bridport	HP	07/06/15 07/08/15 08/04/15	2.5 0.5 4	0 0 0	0 0 0
18. Giards Bay 43"58'44N / 73"24'01W	Bridport	HP	07/03/15 07/06/15 08/04/15	0.5 15 8	0 0 0.6	0 0 13
19. North of W. Bridport 43"57'34N / 73"24'21W	Bridport	HP	07/03/15 07/08/15 07/09/15 08/04/15	1 8 6 4	0 0 1.3 0	0 0 22 0
20. Leonard Bay 43"56'16N / 73"24'00W	Bridport	HP	07/03/15 07/08/15 07/09/15 08/04/15	10.5 53 6 6	0.8 3.3 1 0.8	21 33 20 16

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Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
			08/06/15	1.5	0	0
21. Lapham Bay 43"55'33N / 73"23'37W	Shoreham	HP	07/03/15 08/06/15	12.5 1.5	0 0	0 0
22.South of Lapham Bay 43"54'52N / 73"23'40W	Shoreham	HP	07/03/15 08/06/15	5 1.5	0 0	0 0
23. North of Fivemile Point 43"54'32N / 73"23'40W	Shoreham	HP	07/03/15 08/06/15	2.5 1.5	0 0	0 0
24. Bays on Lake Street South of Fivemile Point 43"54'06N / 73"22'35W	Shoreham	HP	08/03/15 08/06/15	6 1.5	0 0	0 0
25. Access by C. Farr Ranch 43"53'54N/73"22'30W	Shoreham	HP	07/06/15 08/03/15	16 12	6.4 1	69 25
26. N of Larrabees Point 43"51'56N / 73"22'11W	Shoreham	HP	07/06/15 08/03/15	4 2	0 0.6	0 12
27. Beadles Cove and South 43"51'1N / 73"22'15W	Shoreham	HP	07/03/15 08/03/15	25 12	73.8 6.4	1,254 318
28. East Creek (mouth) a. 43"51'50N / 73"22'37W (mouth)	Orwell	HP	06/22/15 08/07/15	8 4.5	1.2 0.5	28 6
28. East Creek b. 43"49'38N/73"21'59W	Orwell	HP	06/22/15 06/23/15 06/29/15 07/30/15	112 16 133 112	257.4 0 500.4 1047.2	6,985 0 6,372 3,472
28. East Creek b. 43"49'38N/73"21'59W	Orwell	HP-TNC				
28. East Creek c. South Fork	Orwell	HP-TNC				
29. Shoreline between East Creek & Catfish Bay 43"49'52N / 73"23'06W	Orwell	HP	07/10/15 08/06/15	2.5 2.5	0 0	0 0
30. Catfish Bay 43"49'40N / 73"23'09W	Orwell	HP	07/10/15 08/06/15	7.5 10	112.8 30.4	2,256 254
31. Buoy 39 Marina 43"49'21N / 73"23'25W	Orwell	HP	06/22/15 07/10/15 08/06/15	8 2.5 2.5	0 0 0	0 0 0

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Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
32. Dock at Curly Audette Farm 43"48'38N / 73"22'41W	Orwell	HP	07/10/15 08/06/15	5 7.5	0 0	0 0
33. North shore Chipman's Point 43"48'7N / 73"22'32W	Orwell	HP	07/07/15 07/10/15 08/06/15	4.5 2.5 7.5	0 0.2 0	0 3 0
34. Shoreline between Chipmans Point and Benson Bay 43"47'07N / 73"21'10W	Orwell, Benson	HP	07/07/15 07/10/15 08/05/15 08/07/15	18 22 4 6	0.2 13 1.4 0.4	5 233 17 8
35. Benson Bay 43"45'50N / 73"20'41W	Benson	HP	06/30/15 08/03/15	12 4.5	2.8 0.9	68 18
36. Shoreline between Benson Bay & Stony Point 43"45'24N / 73"21'16W	Benson	HP	07/06/15 08/03/15	7.5 4.5	0.5 0.5	17 7
37. Stony Point 43"44'37N / 73"21'57W	Benson	HP	07/06/15 08/07/15	2.5 9	0.2 10.4	11 207
38. Shoreline between Stony Point & Benson Landing 43"44'16N / 73"22'05W	Benson	HP	07/06/15	7.5	21.9	548
39. Benson Landing 43"43'45N / 73"22'03W	Benson	HP	07/06/15 07/14/15	3 3	1.4 8.1	47 101
40. Dutchers and South 43"43'01N / 73"22'33W	Benson	HP	07/07/15 07/09/15 07/13/15 07/17/15 07/29/15	24 25 37.5 2 24	31.5 13.4 14.8 0.2 17.3	1,576 334 450 4 225
41. Peters Bay 43"38'12N / 73'25'37W	Benson, West Haven	HP	07/22/15 07/31/15	32 15	422.4 27.9	7,056 254
41. Peters Bay 43"38'12N / 73'25'37W	Benson, West Haven	MH	07/14/15 07/16/15 07/17/15 07/20/15 07/21/15 08/04/15 08/05/15 08/06/15 08/07/15 08/10/15	5 2 18.5 20.5 5 6 5 15 13 13.5	7,600 3,800 53,200 34,200 15,200 7,600 15,200 49,400 38,000 22,800	2 1 14 9 4 2 4 13 10 6

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Site	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
42. Red Rock Bay 43”40’57 N / 73”25’37 W	West Haven	MH	07/13/15 07/14/15 07/15/15 07/29/15 08/05/15 08/10/15 08/11/15 08/12/15	12 14 14 1 2 13.5 13.5 16	53,200 7,600 45,600 3,800 3,800 34,200 19,000 26,600	14 2 12 1 1 9 5 7
43. Cold Spring Harbor 43”40’4.7 N/ 73”24’ 28 W	West Haven	MH	07/21/15 08/14/15 08/17/15	5 13.5 12	19,000 22,800 26,600	5 6 7
44. Horton Marsh 43”39’ 34N/ 73”24’41 W	West Haven	MH	07/21/15 07/31/15 08/03/15 08/04/15 08/05/15	5 10 6 6 5	15,200 34,200 15,200 15,200 15,200	4 9 4 4 4
45. Maple Bend 43”38’52.7N /73”25’2.2W	West Haven	MH	07/29/15 07/30/15 07/31/15 08/03/15 08/04/15 08/05/15 08/06/15	10 25 15 7 9 8 5	11,400 72,200 45,600 30,400 34,200 30,400 11,400	3 19 12 8 9 8 3
46. Poultney River Sites **a. Rogers Marsh** 43”34’06N/73”23’52W	West Haven	HP-TNC				
46. Poultney River Sites **b. Reed Marsh** 43”41’02N/73”21’23W	West Haven	HP-TNC				
46. Poultney River Sites **c. Schoolhouse Marsh & N. Schoolhouse** 43”35’33N/73”23’12W	West Haven	HP-TNC				
46. Poultney River Sites **d. Billings Marsh** 43”36’17N/73”22’39W	West Haven	HP-TNC				
46. Poultney River Sites **e. Finch Marsh** 43”34’36N/73”22’49W	West Haven	HP-TNC				
46. Poultney River Sites **f. Nichols Wetland** 43”37’03N/73”22’30W	West Haven	HP-TNC				

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South Lake Segment NY - 30 sites

Site Name	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
46. Poultney River Sites h. Saslow Marsh 43”36’50N/73”22’26W	Whitehall	HP-TNC				
47. Ottenburgh Ramp a. Lakeside 43”38.5’72N/73”25’11.5W	Dresden	MH	07/21/15	3	7,600	2
			07/22/15	27	79,800	21
			07/23/15	27	72,200	19
			07/24/15	23	76,000	20
			07/27/15	15	60,800	16
			07/28/15	27	83,600	22
			07/29/15	15	57,000	15
47. Ottenburgh Ramp b. Channel Area 43”38’48.5N/73”25’41.1W	Dresden	MH	08/18/15	13.5	30,400	8
			08/19/15	20.5	68,400	18
			08/20/15	27	68,400	18
			08/21/15	27	68,400	18
			08/24/15	7	19,000	5
48. Barrel Bay 43”39’28 N/ 73”24’60W	Dresden	MH	07/21/15	5	11,400	3
			07/27/15	5	7,600	2
			07/31/15	2	3,800	1
			08/03/15	7	22,800	6
			08/04/15	6	11,400	3
			08/05/15	5	15,200	4
			08/06/15	7	19,000	5
			08/17/15	12	34,200	9
			08/18/15	13.5	34,200	9
49. Dresden Landing and South 43”40’16 N/ 73”24’37 W	Dresden	MH	07/24/15	4	7,600	2
			07/27/15	7	22,800	6
			08/03/15	7	15,200	4
			08/05/15	2	3,800	1
			08/12/15	6	15,200	4
			08/13/15	27	95,000	25
			08/14/15	13.5	34,200	9
			08/17/15	3	7,600	2
50. NY Light 14 and South 43”40’45 N / 73”24’43W	Dresden	MH	07/15/15	9	22,800	6
			07/16/15	18.5	45,600	12
			07/17/15	2	3,800	1
			07/30/15	2	3,800	1

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Site Name	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
			08/11/15	13.5	34,200	9
			08/12/15	4	7,600	2
51. Pulpit Point 43”42’45N / 73”23’43W	Putnam	MH	07/15/15	2	3,800	1
52. Bed Back by Railroad 43"42'45N / 73"23'26W	Putnam	HP	07/08/15	23.5	211.5	5,292
			07/09/15	40	396	7,920
			07/13/15	81	1,494	25,515
			07/14/15	109	3,108.8	44,421
			07/16/15	119	2,310	28,900
			07/17/15	119	1,360	68,032
			07/20/15	110	1,242	41,445
			07/21/15	112	1,366.2	34,132
			07/22/15	32	259	5,190
			07/29/15	75	2368	19,832
			08/03/15	16	1,280	13,664
			08/04/14	24	2,160	21,438
			08/05/15	24	3,696	37,312
			08/06/15	16	1,520	17,784
			08/07/15	16	1,964	17,680
			08/10/15	24	1,404	15,522
			08/14/15	63	580	5,275
53. NY Light 4 43"42'48N / 73"23'09W	Putnam	HP	07/09/15	15	70.4	1,776
			07/22/15	64	371	17,446
			07/29/15	7	84.6	768
			07/31/15	65	1,543.5	13,230
			08/10/15	32	78	756
			08/13/15	56	4,166.4	7,728
			08/14/15	9	27.2	303
54. 60 Acre Patch 43"43'21N / 73"22'26W	Putnam	HP	07/13/15	19	0.6	10
			07/16/15	17	8.8	98
			07/17/15	3	0.3	7
			07/29/15	14	2.4	61
55. Sixmile Point and South 43”45'26N / 73"22'00W	Putnam	HP	06/30/15	105	516.6	5,778
			07/06/15	15	15.7	788
			07/08/15	4.5	0.2	77
			08/03/15	15	39.6	1,428
56. South of Gourlie Point 43"46'45N / 73"21'50W	Ticonderoga	HP	06/30/15	9	1.8	45
			07/10/15	4	0.2	2
			08/05/15	4	0.2	2
57. Gourlie Point Bay 43"47'38N / 73"22'25W	Ticonderoga	HP	07/10/15	2	0.8	14
			08/05/15	4	0	0

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Site Name	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
58. North of Gourlie Point 43"47'47N / 73"22'42W	Ticonderoga	HP	07/10/15 08/05/15	4 4	1.2 0.1	22 1
59. Charter Marsh 43"48'16N / 73"23'5W	Ticonderoga	HP	07/10/15	19	0.5	27
60. North of Charter Marsh 43"48'33N / 73"23'11W	Ticonderoga	HP	07/10/15 08/06/15	19 10	0 0	0 0
61. Fort Ticonderoga Bay and South 43"50'17N / 73"23'52W	Ticonderoga	HP	06/26/15 07/10/15 08/04/15 08/07/15	68 36 8 4.5	212 21.4 26 1.9	3,070 356 217 24
62. LaChute River 43"50'42.18N/73"24'08.82W	Ticonderoga	HP - east of railroad	06/26/15 08/04/15	72 8	63.2 28.9	2,412 321
62. LaChute River 43"50'42.18N/73"24'08.82W	Ticonderoga	HP-TNC - west of railroad,				
63. North of Fort Ticonderoga 43"51'29N / 73"23'20W	Ticonderoga	HP	06/29/15 07/06/15 07/07/15 07/08/15 08/05/15 08/07/15	3 12 24 24 7.5 4.5	1.9 101.4 307.8 424.6 3.5 0	38 1038 3132 4323 32 0
64. North of Kirby Point 43"52'42N / 73"23'22W	Ticonderoga	HP	07/07/15 08/05/15	8 16.5	29.8 96.6	466 966
65. South of IPCO 43"53'21N / 73"23'24W	Ticonderoga	HP	08/06/15	3	10.2	127
66. IPCO Bay 43"53'42N / 73"23'50W	Ticonderoga	HP	07/03/15 08/06/15	5 4.5	3.2 5.8	54 97
67. Bay North of Fivemile Point Light 43"54'17N / 73"24'45W	Ticonderoga	HP	07/03/15 07/09/15 08/04/15 08/06/15	24 6 2 9	9.4 0 0 10.6	159 0 0 151
68. North of Crown Point 43"57'15N / 73"24'49W	Crown Point	HP	07/03/15 07/09/15 08/04/15	0.5 4 4	0 1.4 0.4	0 45 7
69. Putnam Creek 43"57'22.2N / 73"24'55.5W	Crown Point	HP	06/25/15 07/03/15 07/09/15 08/04/15	52 0.5 4 8	52.8 0 0.2 17.4	855 0 12 158
70. Porters Marsh 43"58'13N / 73"24'58W	Crown Point	HP	07/03/15 07/09/15 08/04/15	0.5 6 8	0 27 0.7	0 271 17

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Site Name	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
71. Bay south of Burdick Crossing 43"59'4N / 73"25'14W	Crown Point	HP	07/03/15 07/06/15 08/04/15	0.5 5 10	0 0 0	0 0 0
72. Bay at Burdick Crossing 43"59'10N / 73"25'13W	Crown Point	HP	07/03/15 07/06/15 08/04/15	0.5 25 10	0 0 0	0 0 0
73. South of Lapstone Point 44"00'10N / 73"25'02W	Crown Point	HP	07/03/15 07/06/15	1 15	0 7.8	0 390
74. Shoreline between Lapstone Pt & Bay South of Crown Point Bridge 44"00'55N / 73"25'03W	Crown Point	HP	08/05/15	16	0	0
75. Bay south of Crown Point Bridge 44"01'30N / 73"25'06W	Crown Point	HP	07/02/15 08/05/15	21 8	0.2 0.7	5 8

Port Henry Segment NY – 2 sites

Site Name	Location	Control/Entity	Date	Hours	Pounds	Rosettes or MH Loads
76. Bulwagga Bay 44”00’17N / 73”26’51W	Crown Point, Moriah	HP	06/24/15 07/02/15 08/07/15	50.5 35 15	113.6 20.4 0	1424 408 0
77. Bulwagga Bay Campground 44”02’02.76N / 73”27’36.76W	Crown Point, Moriah	HP	06/24/15 08/07/15	40 3	3.8 2.4	94 27

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Appendix D. 2015 Water Chestnut Summary Statistics for 29 Other Water Bodies

Site	Date	Hours	Rosettes	Pounds (est.)	Entity
Benson Landing Road small pond	07/15/15	0.5	0	0	Lakeside contractor
Benson Landing Road small pond TOTAL		**0.5**	**0**	**0**	
Big Marsh Slough, MNWR Total		**59**	**317**	**39**	MNWR
Blissville Wetland	06/01/15	2	0	0.00	DEC, Lakeside contractor
Blissville Wetland	06/11/15	14	9,360	596.17	DEC, Lakeside contractor
Blissville Wetland	06/30/15	27.25	13,213	840.0	DEC, TNC
Blissville Wetland	07/23/15	104	44,642	6,706.4	Lakes, Lakeside contractor
Blissville Wetland	07/24/15	96	62,132	6,820.8	Lakeside contractor
Blissville Wetland	07/27/15	96	50,596	8,626.8	Lakeside contractor
Blissville Wetland	07/28/15	128	41,541	6,002.4	Lakeside contractor
Blissville Wetland	08/23/15	6	262	21.0	Lakeside contractor
Blissville Wetland	08/26/15	4	128	10.25	DEC
Blissville Wetland TOTAL		**477.25**	**221,874**	**29,623.82**	
Brookside Pond	06/27/15	**2**	127	6.4	HP contractor
Brookside Pond TOTAL		**2**	**127**	**6.4**	
Bullis Pond	06/08/15	11	1,658	105.4	DEC
Bullis Pond	06/29/15	6	1,023	65	DEC
Bullis Pond TOTAL		**17**	**2,681**	**170.4**	
Cabot Clark Marsh TOTAL		**20**	**0**	**0**	MNWR
Coggman Creek TOTAL					TNC
Coggman Pond TOTAL					TNC
Cranberry Pool, MNWR TOTAL		**86**	**688**	**92**	MNWR
Dead Creek (6 sites)	07/15/15	104	74	4.4	HP contractor
Dead Creek: Rt 17, north and south	07/02/15	9	37	2.2	HP contractor
Dead Creek: Nortontown Road, north	07/02/15	63	4,191	239.8	HP contractor
Dead Creek: Nortontown Road, north	07/27/15	6	0	0	DEC
Dead Creek, all sites TOTAL		**182**	**4,302**	**246.4**	
Duval drainage ditch	07/08/15	1.5	175	10.3	DEC
Duval drainage ditch	07/27/15	1.5	5	0.2	DEC
Duval drainage ditch TOTAL		**3**	**180**	**10.5**	
Glazenberg small pond TOTAL	**INACTIVE**				
Horton small pond	07/13/15	4.5	12	0.5	HP contractor
Horton small pond TOTAL		**4.5**	**12**	**0.5**	
Lake Bomoseen TOTAL	**INACTIVE**				
Lake Carmi	06/10/15	6	631	40.1	lake assoc.
Lake Carmi	06/29/15	35	496	29.5	lake assoc., DEC
Lake Carmi	07/20/15	4	35	2.2	lake assoc.
Lake Carmi	09/18/15	5	104	6.6	lake assoc.
Lake Carmi	09/23/15	4	23	1.4	DEC
Lake Carmi TOTAL		**54**	**1,289**	**79.8**	
Lake Paran	08/06/15	3	0	0	DEC
Lake Paran TOTAL		**3**	**0**	**0**	

Site	Date	Hours	Rosettes	Pounds (est.)	Entity
Lake Shaftsbury	07/20/15	2	1	0.1	DFPR
Lake Shaftsbury	07/20/15	3	111	7	DEC
Lake Shaftsbury TOTAL		**5**	**112**	**7.1**	
Lemon Fair River	07/11/15	2	0	0	HP contractor
Lemon Fair River TOTAL		**2**	**0**	**0**	
Lily Pond	07/07/15	3	0	0	DEC
Lily Pond TOTAL		**3**	**0**	**0**	
Little Lake	07/07/15	5	0	0	DEC
Little Lake TOTAL		**5**	**0**	**0**	
Long Marsh Channel, MNWR TOTAL		**15**	**0**	**0**	MNWR
North Springfield Reservoir TOTAL	**INACTIVE**				
Parsons Mill Pond TOTAL					TNC
Pelkeys Swamp TOTAL					TNC
Phillips small pond TOTAL	07/13/15	4.5	4	0.2	HP contractor
Phillips small pond TOTAL		**4.5**	**4**	**0.2**	
Porter Lake	07/15/15	18	413	16.5	HP contractor
Porter Lake TOTAL		**18**	**413**	**16.5**	
Richville Pond	07/11/15	4	7	0.2	HP contractor
Richville Pond TOTAL		**4**	**7**	**0.2**	
Root Pond TOTAL					TNC
Singing Wetland TOTAL	**INACTIVE**				

PART II: TNC PROGRAM

Objectives

The Vermont Chapter of The Nature Conservancy (TNC) has organized its ongoing Water Chestnut Management Program every summer since 1998 to reduce the threats that water chestnut (*Trapa natans*) poses to conservation targets in the Lake Champlain Basin. The Conservancy has identified eight conservation targets in the Southern Lake Champlain Valley. Two of these eight targets are adversely affected by water chestnut: 1) wetland, floodplain, and riparian natural communities; and 2) the littoral aquatic communities.

Management Summary and Changes to Program in 2015

TNC staff organized 38 workdays in 2015 between June 26 and August 25th, harvesting 4,336 pounds of water chestnut. Handpulling activities were conducted at 25 sites, and volunteers donated a total of 287 hours of labor to water chestnut management (Table 3). As in past years, TNC staff continued to focus on sites considered ecologically significant[3]: East Creek, Poultney River Wetlands, and South Bay's southern end. In addition, inland sites continued to be handpulled, including Parson's Mill Pond, Root Pond, and Pelkeys Swamp.

In 2015, Jesse Smith worked as the seasonal Water Chestnut Field Coordinator, and led most of the fieldwork. Paul Marangelo, Senior Conservation Ecologist for TNC's Vermont Chapter, supervised the Field Coordinator, provided administrative, logistical, and field support, and worked on volunteer recruitment.

Workdays were scheduled to minimize the probability of inadvertently dispersing zebra mussels to non-infested waters. Canoes and kayaks were washed and sun-dried after each workday, and TNC staff made an attempt to not schedule any workdays at non-infested sites immediately after a workday at an infested site.

Paul Marangelo searches for water chestnut at the La Chute River (VTDEC)

[3] Sites that are noted by the Vermont and/or New York Natural Heritage Program databases as containing rare/high quality natural communities and/or rare species.

Table 3. Volunteer hours and water chestnut harvest summary data by year

	Days	Volunteers	Hours	Sites	Pounds	Rosettes
1998		64	1088	12	17775	X
1999	33	282	1554	11	154620	X
2000	46	315	1861.5	15	109170	X
2001	45	259	1463.5	20	87435	X
2002	34	148	724.5	17	14219	X
2003	34	238	941	17	30225	X
2004	42	222	1143	21	17651	X
2005	45	292	1225.5	29	16412	187,568
2006	49	232	1384	22	12864	60,244
2007	49	307	1380	23	9771	47,956
2008	45	253	1212	24	17270	81,462
2009	39	203	787	23	6845	29,297
2010	40	185	681	24	5445	30,527
2011	48	64	537	26	6903	34,323
2012	38	55	347	21	5756	30,787
2013	40	51	373	21	9024	44,661
2014	42	34	164	24	7315	55,891
2015	38	26	287	25	4336	39,235
Total			**16,866**		**528,700**	**602,716**

Volunteers

We continued to recruit volunteers to assist with water chestnut management efforts, via newspaper calendar announcements and bulk mailing to previous year's volunteers. This year, 26 volunteers contributed 287 hours (Table 3).

Given the progress the program has made in controlling water chestnut populations, there are now fewer sites with large numbers of plants that are well-suited for volunteer work groups. TNC has accordingly evolved its approach for water chestnut management towards using volunteers on a more limited basis at a smaller set of sites than in the early years of the program. Our effort to recruit new volunteers has therefore been reduced to a level that is commensurate with meeting the goal of maintaining an optimum level of volunteer engagement, where the time spent orchestrating volunteer workdays and managing individual and group of volunteers is most efficient in terms of programmatic cost, time, effort, and work achieved.

One volunteer group returned from previous years to pull water chestnuts: Barn Day Camp of Plymouth, VT. In addition to youth groups, four interns from TNC's Leaders in Environmental Action for the Future program contributed to water chestnut management efforts in July, as did staff from the Lake Champlain Basin Program during a staff outing.

In addition to the contributed hours, TNC staff Field Coordinator Jesse Smith, Conservation Ecologist Paul Marangelo, and Americorps Volunteer Coordinator and Field Assistants Josh Jones and Jamie Dilon logged 308 hours of field work.

Methods

Since water chestnut is an annual plant, repeated annual harvesting of rosettes before mature seeds drop is an effective way of controlling populations. TNC staff and volunteers search for and handpull water chestnut rosettes in targeted wetland sites throughout the growing season via visual searches from canoes and/or kayaks.

The objective for each managed site is to search for and handpull all existing water chestnut rosettes. Once pulled, harvested water chestnut is placed in Gardener's Supply bags and weighed with a spring scale. TNC staff estimates the number of rosettes handpulled by weighing and counting a subset of handpulled rosettes. The total daily rosette harvest is estimated by extrapolating the measured rosette/lb ratio to the entire harvest weight at a given site.

Results and Discussion

Water chestnut harvest generally continues to exhibit a general pattern of decline or stabilization at most of the sites under active hand-pulling management. However, a small number of notable exceptions have occurred over the past few years, where anomalous increases in harvests were found. While no such increases were noted this past season, one site maintained anomalously high abundances of water chestnut (East Bay).

Sixteen of our sites are isolated ponds or wetlands, and therefore receive few if any water chestnut propagules (seeds) from other infested sites. These sites therefore can be considered directly responsive to site specific management efforts: because there are no seeds entering these sites from other infested areas, our annual hand pulling efforts can be expected to vastly diminish if not curtail the reproductive success of water chestnuts within a given site, and we can attribute any changes in patterns of water chestnut abundance over a series of years to the effectiveness of our annual handpulling efforts.

Our hand-pulling efforts were supplemented by work done by VTDEC-contracted hand-pulling crews in 2015 at East Creek and La Chute River Wetlands. We also supplemented VTDEC hand-pulling efforts at Blissville Pond in Poultney, Vermont, a new site for which we contributed a day of hand-pulling efforts towards.

The most noteworthy site-specific results in 2015 area as follows:

Coggman Creek, West Haven, VT

We visited this site for the first time in 2015 to scout for the presence of water chestnut, found a number of plants, and ended up pulling 119 pounds of water chestnut. Water was backed up by beavers at this site around 2007 and now features approximate 20 acres of water chestnut habitat. Plants were not particularly abundant at this site, and future annual hand-pulling should be able to keep the number of plants in check.

East Bay, West Haven, VT

In 2013 and 2014, this site was not completely harvested, on account of work demands from other project sites. Accordingly, we found large numbers of plants at a portion of this site in 2015, in the wetlands flanking both sides of the railroad bridge to South Bay. We generally place a lower priority on this site, since it is comprised of wetlands and shoreline that constitute part of Lake Champlain and frequently accumulate water chestnut from drifting plants dislodged elsewhere in the lake by mechanical harvesting. Indeed, large numbers

of plants dislodged from the mechanical harvesting south of the railroad bridge were observed in this area this season. It is likely that high numbers of plants will appear in these wetlands next season.

Table 4. Pounds[4] of water chestnut harvested by year per site, 2004 – 2015

Site Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Billings Marsh	50	132	975	157	275	149	118	2135	3866	310[5]	233[5]	246[5]
Brookside Pond	VTDEC	957	412	693	705	51	37[6]	30[6]	286[6]			
Coggman Pond	87	18	26	39	84	74	35	37	24	140	25	119
Coggman creek	X	X	X	X	X	X	X	X	X	X	XX	121
Cook Island West	173	X	X	1839	1109	105	175	14	149	73	959	225
Culvert Bay NY	X	X	X	X	X	X	X	X	X	143	234	54
East Creek	996[7]	1281	2315	341	565[6]	2429[6]	992[6]	136[6]	437[6]	2092[6]	2426[6]	2441[6]
Finch Marsh	413	178	124	187	189	61	137	208	X	1726	45	63
Finch Marsh Outlet	490	15	0	0	10	51	0	X	14	X	X	1
Hubbarton Ponds	X	0	X	X	X	0	X	X	X	0	X	X
Inman Pond	X	0	X	X	X	X	X	X	X	X	X	X
La Chute River Marshes	VTDEC	VTDEC	418	334	3606[6]	3495[6]	1848[6]	1919[6]	360[6]	223[6]	187[6]	314[6]
Little Cat Den Bay	X	X	X	X	X	X	X	X	63	20	237	63
Nichols Wetland	31	203	280	18	44	5	113	48	38	359	247	181
Mill Bay	X	X	X	X	3220	X	X	X	X	X	X	X
Old Marsh Pond	X	0	X	X	0	X	X	0	X	X	0	X
Parsons Mill Pond	365	400	697	181	199	198	137	360	110[6]	36[6]	64	294
Pelkey Swamp	2 plants	**0**	1 plant	15	20	36	56	15	35	127	49	181
Reed Marsh	183	264	94	287	236	64	61	25	64.5	84	56	45
Rogers Marsh	3 plants	6 plants	2 plants	26 plants	93	28	1	5	10	1	4	6
Root Pond	10 plants	X	10 plants	6 plants	6	2	17	4 plants	0	1	9	16
East Bay	1241	270	981	1042	2091	191	1035	1417	164.7	8	3012	160
Saslow Marsh	70	48	76	94	133	88	206	58	15	106	12	10
Schoolhouse Marsh	57	43	20	4	7	5	51	18	118	130	61	35
Schoolhouse Marsh North	83	51	43	70	133	22	99	495	6	23	8	11
South Bay	173	30	43	91	53	83	53	32	33	210	49	60
South Bay/Timber Marsh	X	644	826	153	641	698	293	172	326	4343	1049	476
South Bay/Harvester sites	X	X	X	3120	2366	X	X	X	X	X	X	X
South Fork	87	263	324	134	17	66	200	213	265	582	322	266
The Drowned Lands	13006	10359	X	X	X	X	X	X	X	X	X	X

[4] 2001 pounds are estimates made from number of bags filled: 1 full bag = 90lbs of water chestnut.

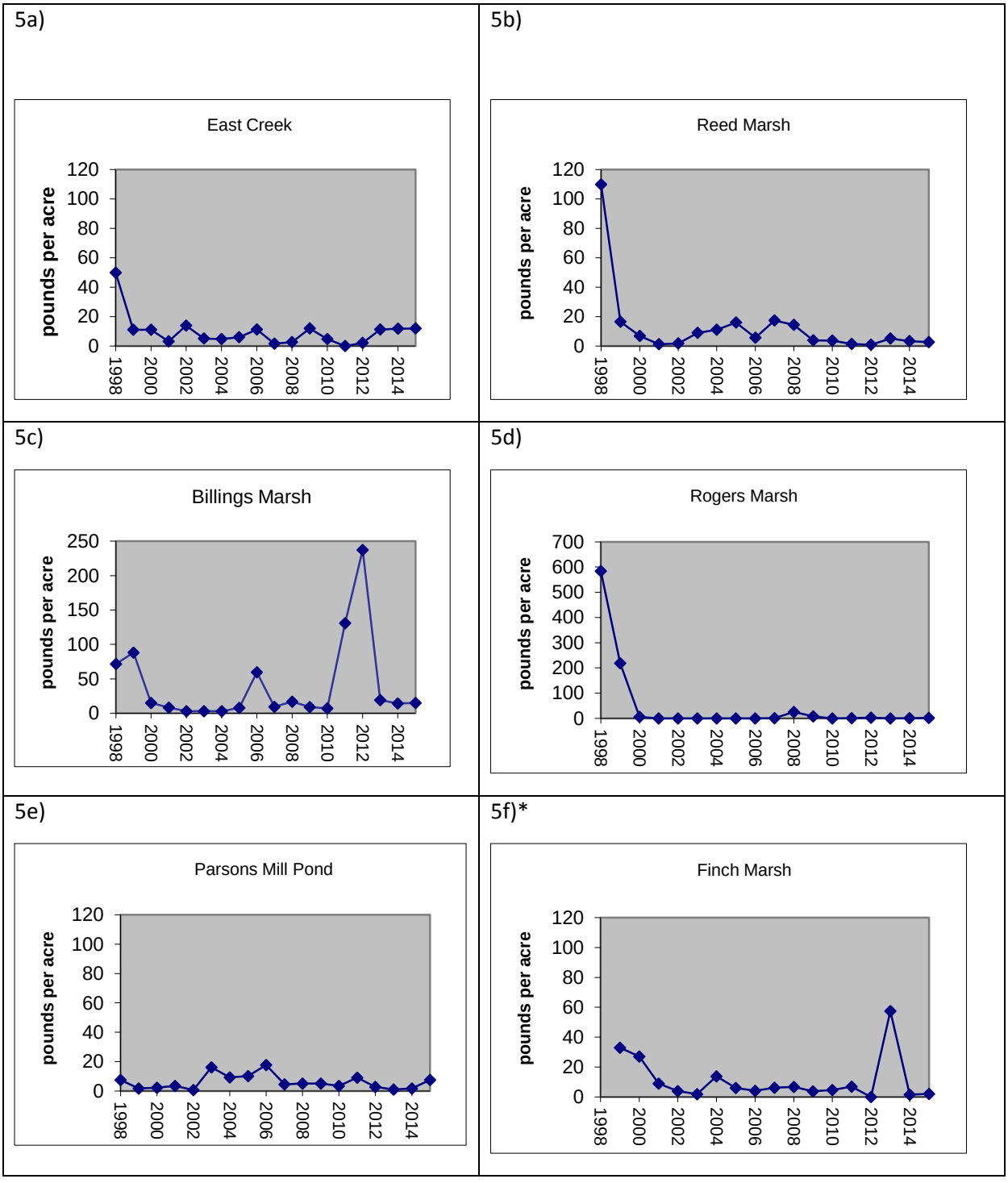
[5] VTDEC – site treated by the Vermont Department of Environmental Conservation

[6] Combined harvest from VTDEC and TNC

[7] Additional harvest conducted by VTDEC at the mouth of the creek

X – Site not visited by TNC

Figure 9a-f. Water Chestnut harvest trends at six sites in the Southern Lake Champlain Valley, 1998 – 2015



* no harvesting effort in 2012 - site dewatered by beaver dam breach

Conclusions

After 18 years of water chestnut control efforts, TNC's Water Chestnut Management Program continues to be successful at maintaining reduced levels of water chestnut infestation that were achieved after the initial years of the program. Although some sites have exhibited sometimes puzzling increases in water chestnut harvests within the past few years, we have been able to successfully manage these "outbreaks" and reduce water chestnut populations in subsequent years with persistent management effort, as exemplified by the contrast between 2013 vs. 2011/12 harvests at Billings Marsh. Overall, program-wide results illustrate that substantial gains in water chestnut management have been maintained over the years at the majority of our sites. Still, it is unlikely that water chestnuts can be completely eradicated at any given site – it is very difficult to find and pull every last water chestnut plant in wetlands with extensive areas of emergent vegetation that even with adequate water levels, are challenging to access by boat. We anticipate the need for continual "maintenance treatment" management at these sites in future years, as we continue to find small numbers of plants every year at most sites.

In the early years of TNC's Water Chestnut Management Program, our volunteer-based focus provided the capacity to achieve substantial gains in managing this plant in a cost effective way that also provided ancillary benefits of educating volunteers about water chestnut, Lake Champlain, and Aquatic Nuisance Species issues. TNC's program now uses volunteers to a lesser degree, focusing volunteer use where they can provide the most benefit. Our experience has been that the use of volunteers is most effective where water chestnut is abundant and easy to find and pull. Hand pulling water chestnut is not well suited for most volunteers whenever the work requires painstaking searches through emergent wetland vegetation for a few scattered plants, except for a very small number of experienced volunteers who return each year and greatly benefit this work.

Acknowledgements

Funds for this program were provided by the Lake Champlain Basin Program.

Appendix E. 2015 Water Chestnut Site Summary Statistics, The Nature Conservancy, Vermont Chapter

Site	Date	Pulling hours	Volunteer hours	Pounds	Rosettes
Billings Marsh	7/15/2015	26	40.5	183	1109
	8/1/2015	6.5	7	35	319
	8/7/2015	2	0	18	88
	8/17/2015	2	5.75	10	39
Billings Marsh Total		**36.5**	**53.25**	**246**	**1555**
Blissville Wetland Total	6/30/2015	**21.25**	**6**	**840**	**13213**
Coggman Creek	7/31/2015	3.25	0	66	286
	8/14/2015	10.5	9	55	289
Coggman Creek Total		**13.75**	**9**	**121**	**575**
Coggman Pond Total	7/14/2015	**5.16**	**0**	**119**	**1347**
Cooks Island	6/29/2015	4	0	41	458
	8/20/2015	2.3	0	184	617
Cooks Island Total		**6.3**	**0**	**225**	**1075**
East Creek	7/9/2015	22.5	28	151	1284
	7/10/2015	23.31	35	187	1883
	7/13/2015	17.28	33	196	1205
	7/20/2015	10.5	0	28	159
	8/24/2015	9	8	75	246
East Creek Total		**82.59**	**104**	**637**	**4777**
Finch Marsh	7/2/2015	27.5	36	47	696
	7/17/2015	5	0	10	105
	8/4/2015	0.5	0	0	0
	8/25/2015	1.5	0	6	34
Finch Marsh Total		33	36	63	835
Finch Marsh Outlet Total	7/29/2015	0.16	0	1	7
Nichols Wetland	7/23/2015	5.5	0	135	767
	7/24/2015	1.25	0	34	193
	8/17/2015	2	5.75	12	57
Nichols Wetland Total		**8.75**	**5.75**	**181**	**1017**
Parsons Mill Pond	7/8/2015	18	35	203	2402
	8/13/2015	17.5	13.5	91	739
Parsons Mill Pond Total		**35.5**	**48.5**	**294**	**3141**
Pelkey Swamp	7/6/2015	7.5	4	36	374
	8/4/2015	0.5	0	10	20
	8/12/2015	5.8	0	135	387

Site	Date	Pulling hours	Volunteer hours	Pounds	Rosettes
Pelkey Swamp Total		**13.8**	**4**	**181**	**781**
Reed Marsh	7/30/2015	6.75	4	41	225
	8/7/2015	2	0	4	10
Reed Marsh Total		**8.75**	**4**	**45**	**235**
Rogers Marsh	6/29/2015	0.5	0	0	0
	8/20/2015	0.5	0	6	14
Rogers Marsh Total		**1**	**0**	**6**	**14**
Root Pond Total	**7/7/2015**	**3.5**	**0**	**16**	**461**
N. Schoolhouse Marsh Total	**8/3/2015**	**2.5**	**0**	**11**	**110**
Saslow Marsh Total	**8/5/2015**	**3**	**0**	**10**	**42**
Schoolhouse Marsh Total	**7/29/2015**	6	0	35	146
South Bay Total	**7/22/2015**	**19**	**0**	**60**	**715**
South Fork (East Creek)	6/26/2015	20	6	119	1749
	7/27/2015	5.75	0	87	432
	7/28/2015	5	0	60	298
South Fork (East Creek) Total		**30.75**	**6**	**266**	**2479**
Culvert Bay	7/16/2015	4	0	50	461
	8/10/2015	1	0	4	19
Culvert Bay Total		**5**	**0**	**54**	**480**
Little Cat Den Bay	7/16/2015	4	0	34	338
	8/10/2015	2.5	0	29	120
Little Cat Den Bay Total		**6.5**	**0**	**63**	**458**
LaChute River Wetlands Total	**8/18/2015**	**32**	**10**	**226**	**1195**
East Bay*	6/29/2015	12	0	33	369
	7/16/2015	0.5	0	45	447
	8/20/2015	1.5	0	82	275
East Bay Totals		**14**	**0**	**160**	**1091**
South Bay (Timber Marsh)	8/19/2015	11.5	0	476	3486
South Bay (Timber Marsh) Total	**8/19/2015**	**11.5**	**0**	**476**	**3486**
Season Totals		**400**	**287**	**4336**	**39235**

* site formerly called "South Lake Champlain"

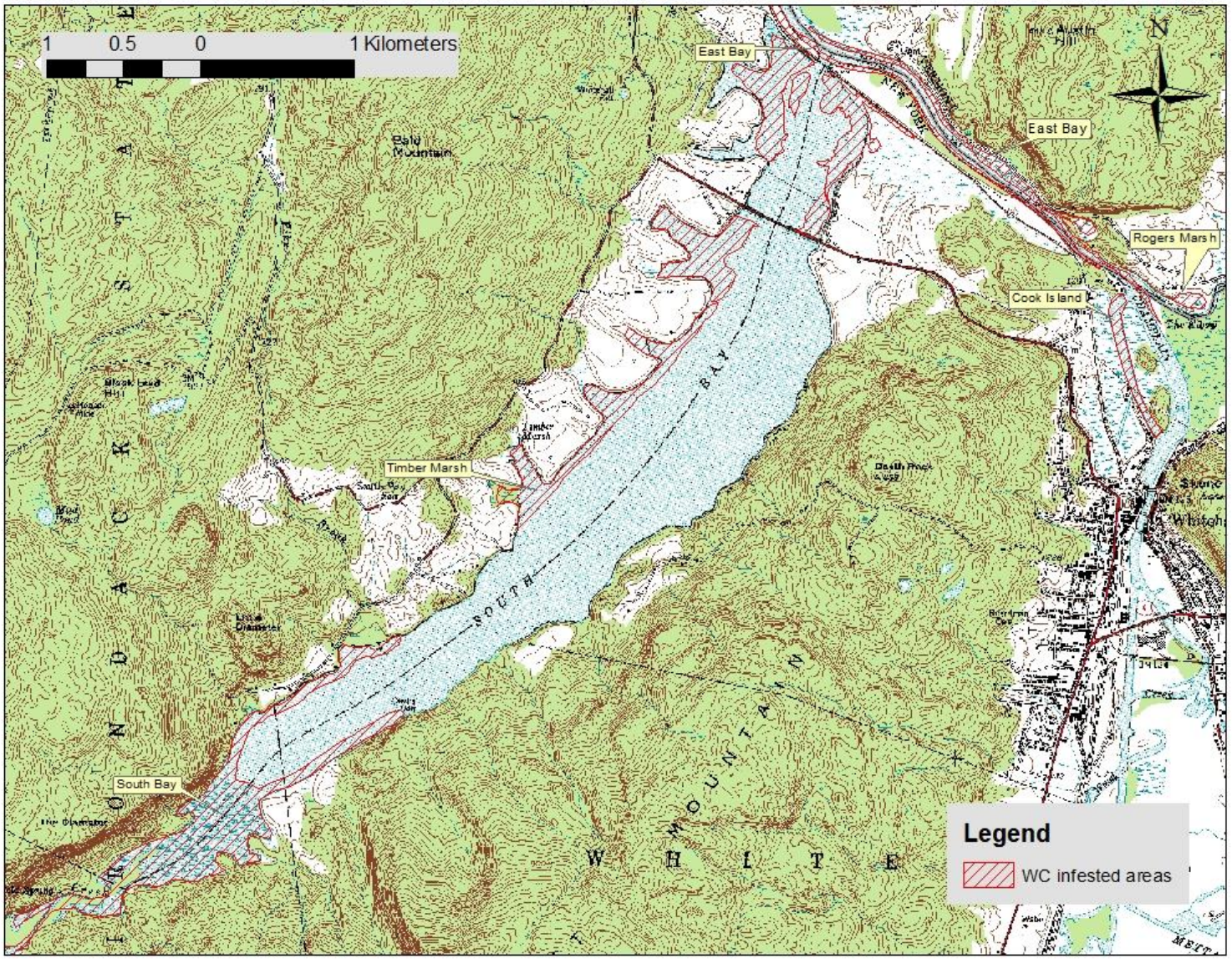
Appendix F. Program Funding

Funding sources, 2005 – 2015

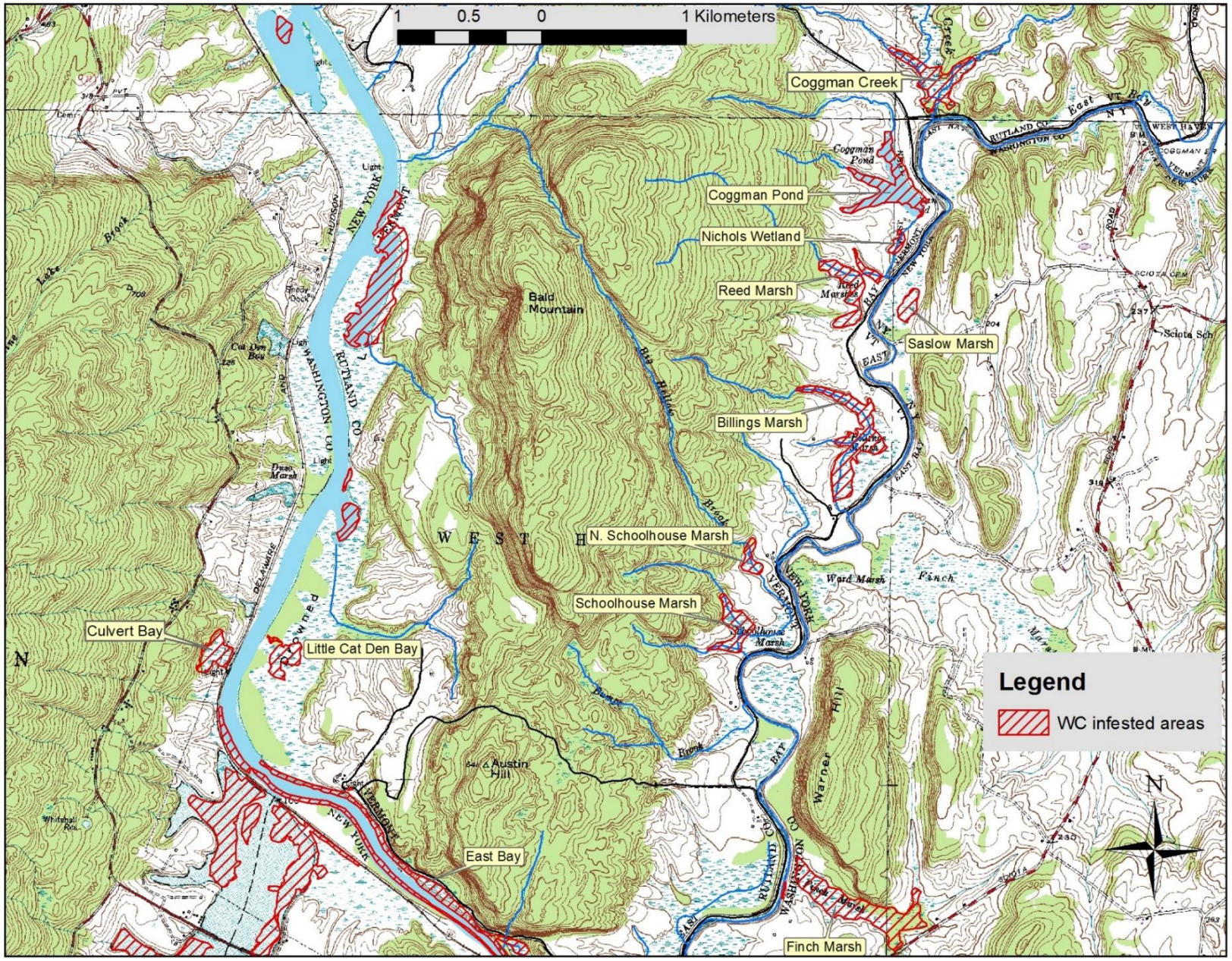
Year	LCBP/VTDEC	USFWS (Partners for F&W program)	Waterwheel Foundation	South Lake Champlain Trust	USDA NRCS WHIP	Totals
2005	$13,000.00	$3,000.00	$6,578.00	$1,000.00	$1,339.00	$24,917.00
2006	$13,000.00	$2,000.00	$15,000.00[1]	$0.00	$2,653.00	$32,653.00
2007	$13,000.00	$0.00	$9,295.00	$0.00	$2,653.00	$24,948.00
2008	$13,000.00	$0.00	$8,925.00	$0.00	$2,653.00	$24,578.00
2009	$15,000.00	$0.00	$0.00	$0.00	$2,653.00	$17,653.00
2010	$20,000.00	$0.00	$1,450.00	$0.00	$1,314.00	$22,764.00
2011	$20,000.00	-	$950.00	-	-	$20,950.00
2012	$20,000.00	-	$150.00	-	-	$20,150.00
2013	$20,000.00	-	$1,200.00	-	-	$21,200.00
2014	-	-	$1,200	-	-	$21,200.00
2015	-	-	-	-	-	-

[1] Funds were used to purchase a replacement truck for program use in 2006.

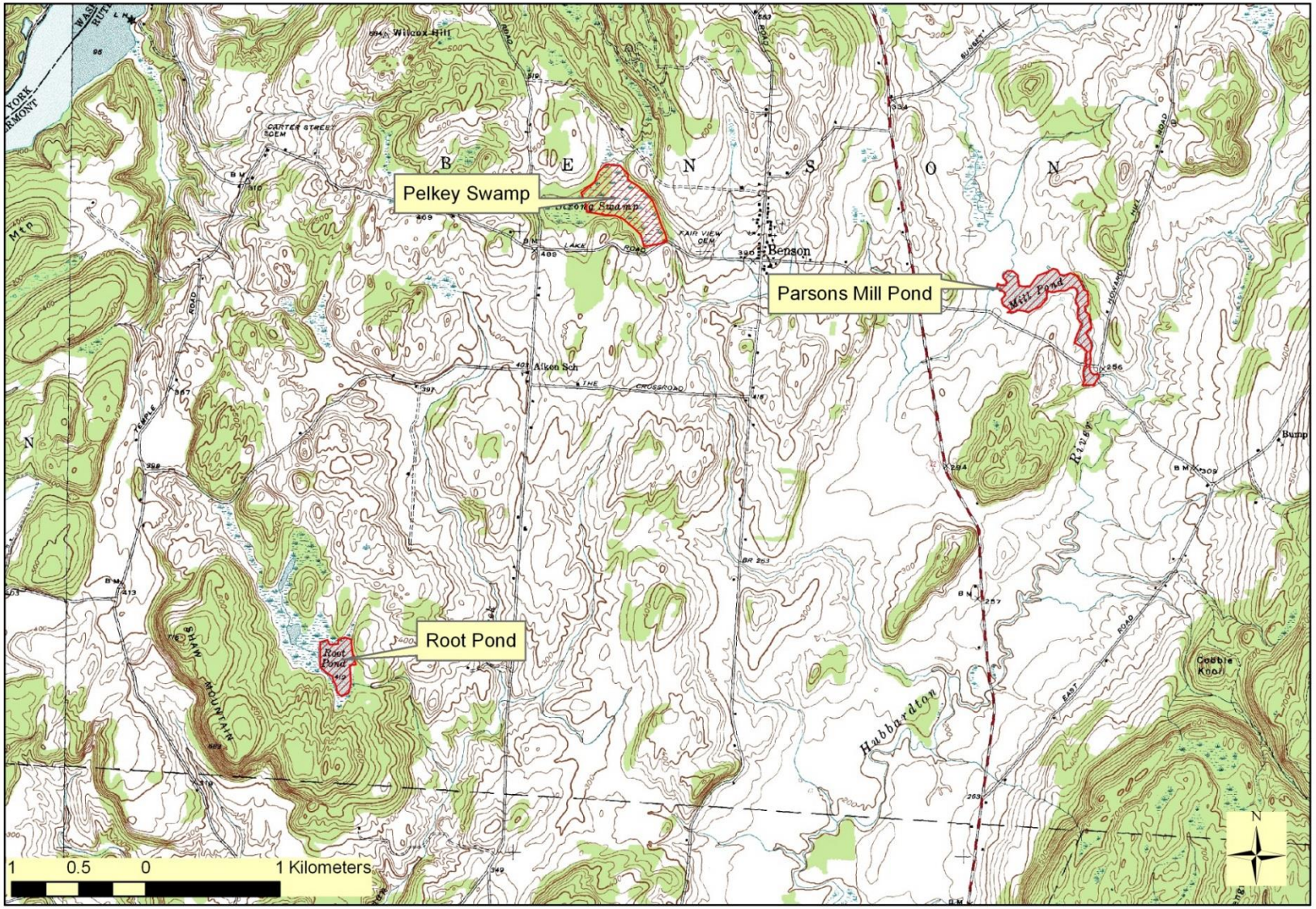
Appendix G. Site maps



Water chestnut hand-pulling sites around South Bay, Lake Champlain, 2015.



Water chestnut hand-pulling sites along the lower Poultney River, VT and NY, 2015.



Water chestnut hand-pulling sites near Benson, VT, 2015.